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THE
QUARTERLY JOURNAL.

VOLUME XV.

THE

QUARTERLY JOURNAL

OF

SCIENCE,

LITERATURE, AND THE ARTS.

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TO OUR READERS AND CORRESPONDENTS.

The serious inconvenience and delay occasioned in the printing of this Journal, by allowing private copies of particular papers to be struck off for their respective authors, obliges us very reluctantly to announce to our correspondents, the absolute necessity of discontinuing that practice in future.

We are much indebted to our "OLD CORRESPONDENT" for his observations on Electro-magnetism, but he is evidently unacquainted with all that Oersted has achieved in this department of science. *Palmam qui meruit, ferat.*

F. R. S. has reached us, but we cannot, either directly or indirectly, interfere in the subject of his letter.

We are much flattered by the proposal of a "PROPRIETOR OF THE LONDON INSTITUTION," but cannot afford the space which his plan would require.

The Letter of "BIBLIOPHILUS," respecting the destination of the King's Library, reached us too late for insertion, and we fear that, before our next publication, its doom will be fixed. Should the subject not fall into abler hands, which we hope it will, we shall, upon a future occasion, offer a few remarks upon his proposal for a National Museum.

In consequence of the extent of several papers in this Number having exceeded our expectation, we have been obliged to omit the article on the Progress of Foreign Science, and have incorporated the most important parts of it with the *Miscellaneous Intelligence.*

On referring to the Notice to Correspondents, prefixed to our Twenty-Seventh Number, Mr. JOHN REID will find that he has entirely mistaken our motives for withholding his paper. We have now disposed of it according to his directions.

The communication from Birmingham we have again been obliged to postpone, in consequence of want of room for the plate. If the author wishes it returned, it shall be left for him at Mr. MURRAY'S.

We are sorry to decline the communication, signed S. Perhaps the author will see our motive in an article in the present Number. His paper is preserved, and shall be disposed of as he may direct.

B. N. D. must excuse us.

"ELECTRO-MAGNETICUS" requires some consideration. We shall endeavour to reply to him in our next Number.

If our Correspondent at Rouen will refer to Sir H. DAVY'S paper, "On the Fallacy of the Experiments in which Water is said to have been formed by the Decomposition of Chlorine," in the *Phil. Trans.* for 1818, he will find answers to all his queries.

Several papers have reached us too late for insertion, and will be disposed of according to the notice in our last Number. As we only publish *quarterly*, many subjects of temporary interest, which our Correspondents are kind enough to communicate, are thus rendered useless. This is especially the case with Mr. SUTHERLAND'S paper, which was only received last night.—March 25.

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ii. Traité Elémentaire de Réactifs, leurs Preparations, leurs Emplois speciaux, et leurs applications à l' Analyse. Par MM. A. PAYEN, Manufacturier; et A. CHEVALLIER, Paris, 1822. 8vo. pp. 224 326

iii. Reliquiæ Diluvianæ; or, Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel; and on other geological Phenomena attesting the Action of an Universal Deluge. By the Rev. WILLIAM BUCKLAND, B.D., F.R.S., &c. 337

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TO OUR READERS AND CORRESPONDENTS.

Mr. Vulliamy's paper on the Theory of the Dead Escapement, will appear, with its illustrative plates, in our next Number.

Mr. Johnstone's "Analytical Inquiries into the Nature of Nitrogen and Ammonia," reached us too late for insertion; the paper, therefore, is disposed of according to his directions.

We have received the "Edinburgh Critic;" but his remarks appear to us very irrelevant.

A Member of the Apothecaries' Company is informed that we shall probably give some account of the New Laboratory, and of the mode of conducting business in it, in our next Number.

A Correspondent, who writes to us upon the subject of Gas Works, and signs himself "*Anti-Alarmist,*" is too voluminous, even for a Quarterly Journal.

We must decline all interference upon the subject of Mr. W. C.'s Letter.

Mr. Wrangham's paper shall appear in our October Number, provided he has no objection to its standing over till that time.

We recommend a little more circumspection to our Correspondent, who calls himself a "Practical Chemist." The Numbers in our Table of Equivalents to which he alludes, are any thing but theoretical, and are deduced, in all cases, from the *experiments* of others, or from original ones of our own. The number for gold with which he particularly quarrels, happens to be deduced from the analysis of the insoluble iodide, and as it closely corresponds with that derived from an analysis of the triple chloride of gold and potassium by Berzelius, we had no hesitation in adopting it. We cannot help its slight disagreement with the experiments of MM. Pelletier, Oberkampf, *&c.* Had we entered into all our experimental details and data, we must have written a volume.

NEW WORKS PREPARING FOR PUBLICATION.

Essays on Meteorology, by J. F. Daniell, Esq., F.R.S. 1 vol. 8vo.
A System of Mineralogy, by J. Mac Culloch, M.D., F.R.S.
A Manual of Pharmacy, by W. T. Brande, F.R.S. 1 vol. 8vo.

ERRATUM.

In Mr. Davies Gilbert's paper "On the Vibrations of Heavy Bodies," the first two lines in page 97, should follow the Table, page 103.

THE

QUARTERLY JOURNAL,

April, 1823.

Art. I. *On the Curvature of the Arches of the Bridge of the Holy Trinity at Florence.* *By* Samuel Ware, Esq.

[*To the* Editor *of the Quarterly Journal of Science and the Arts.*]

To determine the curvature of the arches of the marble * bridge of the Most Holy Trinity erected over the Arno at Florence by Bartolommeo Ammanati, is a problem which still occupies the attention of antiquaries, mathematicians, and architects. Some account of the interest this question has excited, will be found in Ferroni's tract entitled "Della vera curva degli archi del Ponte a S. Trinità di Firenze; discorso geometrico-storico," inserted in the 14th vol. of the Transactions of the *Società Italiana delle Scienze*.

When it is observed, that the curvature of these arches affords the flattest roadway, and the greatest waterway, with the smallest quantity of material of any stone bridge ever constructed, and taking into consideration that cast-iron is ten times stronger than marble, and twelve times stronger than common stone in compression, and that the vault of this bridge is less in depth from the intrados to the extrados, than any iron bridge hitherto built, with relation to the radius of curvature at the vertex*; we shall not wonder that the inquiry should be continued until a satisfactory solution be obtained. The following attempt to solve this question has been made, in the hope of rendering so excellent a bridge more generally known than it is at present, and to mark it as an object for imitation, now that it is in contemplation to erect a new bridge in the place of London Bridge. Perhaps the inquiry may cause hereafter some proper applications of geometry and known formulæ to be made to elliptical curves, of which, judging from the arches of this kind which are to be seen in very conspicuous places in London,—modern builders appear to be unacquainted with. The historical inquiries of antiquaries have been suspended, for they cannot find in the memoranda of Parigi any account of the nature of the curve, nor trace the lost manuscript work of Ammanati, entitled *La Città*, beyond the possession of the Great Prince Ferdinand of Tuscany. Mathematicians to the time of Ferroni, contented themselves principally with conjectures derived from the resemblance of the curves of the arches of this bridge to other curves, sometimes concluding them to be composed of arcs of circles of different radii, at other times ellipses, parabolas, or catenaries. Some more industrious have measured the arches by taking ordinates, or various triangles, with such implements as lines and tapes. But as the absolute curve had not been accurately obtained before Ferroni's time, consequently the curve of Ammanati could not be satisfactorily deduced. Ferroni employed in 1785, Joseph Salvetti, to measure correctly the middle arch of this bridge by ordinates at each braccio, and he states proper implements were provided, and that the ordinates were measured twice over; different measurements have since been published, but not such as to cause any doubt to be entertained of Salvetti's accuracy. Ferroni having thus obtained the clew, he found the labour of unwinding it more irksome than invention: he therefore assumed the curve to be a scheme, and having placed together six arcs of circles approximating to the curve, concluded that he had found out the curve itself. He was led to such a proceeding by the example of modern French architects, who are very ingenious in coaxing arcs of circles into an approximation to a continued curve which they call *anses de panier*, as substitutes for regular curves, in order to evade a little trouble in setting out the voussoirs of arches, (not arcs of circles,) or from not knowing the method of doing it.

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* This bridge is only faced with marble, the vault between the faces is built with ordinary stone, coarsely wrought, but bonded at intervals from face to face, by stone of a better sort properly worked.

---

* In the Ency. Méth. Arch. Art., Ammanati. This bridge is thus described: "Son goût, sa hardiesse, et sa légèreté, le font passer pour le plus beau de l'architecture moderne."

The accompanying drawing, CEG., Fig. 1. of the curve of the middle arch is correctly drawn to Salvetti's ordinates, to a scale of Florentine braccia [*], and is manifestly a Gothic pointed arch of the time of Henry VII. In the beginning of the reign of Henry VIII, Torregiano [†] came to England from Florence to erect the tomb of Henry VII, he returned also to Florence as *Cellini* relates, to engage several youths to assist him, and he finished the tomb in 1519. During his stay in England, the chapels of St. George, Windsor, of Henry VII, Westminster, and of King's College, Cambridge, were in progress; in which buildings, arches, similar to that of the bridge of Ammanati, had been partially introduced as principal arches, and it is probable from the novelty of their appearance in such situations, that the form attracted the attention of Torregiano and his *pupils*, and by them it was introduced at Florence to the notice of artists, among whom, in 1526, Ammanati [‡] must have been a student. The fitness of this curve [§] to the Bridge of S. Trinità induced Ammanati in 1566, to adopt it, though a Gothic curve; but obedient to the prevailing taste, he dressed it in the then fashionable costume of Roman architecture; but the ornaments at the vertices of the arches, seem intended only to veil his obligations to Gothic science, not like the skreen wall of St. Paul's Cathedral, to conceal those of Sir C. Wren.

---

[*] A braccio is divided into 20 soldi, a soldo into 12 danari. A braccio = 1.9 feet English. See Dr. Young's Lectures on Natural Philosophy.

[†] Vol. I, page 162, Walpole's Anec. of Painting.

[‡] See Malizia Memorie degli Architetti.

[§] Ferroni says, before the time of Ammanati, there is no example of such an arch.

During the time that vaults were erected over ecclesiastical buildings, arches of this kind, being nothing more than elongated pointed arches, or arcs of ellipses, would have been obtained in the following manner. Draw a right angled triangle, ABC, and divide the hypothenuse and one of the sides AB. each into an equal number of parts proportionally. Upon AB. describe a quadrant of a circle, and at right angles through the points of division, draw the semichords, which transfer to the corresponding points of division in the hypothenuse, as an absciss for ordinates, hence the curve CEG required; the directions of any joint E of two voussoirs, would be obtained thus,—with the vertex V of the curve so obtained as a centre, and radius equal to the hypothenuse BC, cut the hypothenuse BC, continued in F and f; draw the right lines EF and E f, and bisect the angle FEf, the line of bisection is, the direction of the joint required. In the works which are published of Gothic architecture, it is assumed that arches of this character are, in ancient buildings, composed of arcs of circles, but arches so generated only characterize and betray modern imitations, and oftentimes the restorations of Gothic architecture of the time of Henry VII. There may possibly be in some ancient building, examples of such mis-shapen arches, but I have not been able to find among the numerous publications of Gothic architecture, any such arch drawn from ordinates, to confirm such conclusions. It is manifest that the diagonal ribs in Gothic groined vaulting, must be arcs of ellipses; and if there be any examples of the corrupt practice before mentioned in this country, they are of a later date, when Gothic architecture had declined.

If the curve obtained by Salvetti be tried in a few cases with the given ordinates and abscisses by the common formula $\frac{y^2}{x}p=$, when $y =$ the ordinate, $x =$ the absciss, and $p =$ the parameter of a parabola, it will be manifest that it is not a parabola.

In like manner by the formula $\frac{\text{log. tang. } (45^\circ + \frac{1}{2}\varphi)}{\text{sec. } \varphi \text{ ver. sin. } \varphi.} = \frac{y}{mx}$.

when φ denotes the angle of the curve with its ordinate, and $m = 2.302585$ to find φ by approximation, and thence the constant quantity $= \dfrac{x}{\text{sec.}\,\varphi - 1}$, some doubt may be entertained, whether it was designed to be a catenary, for in five cases by calculation, the longest constant quantity was 2.59, and shortest 2.46.

It may be observed that if the curve had been an arc of a parabola or of a catenary, curves likely to be adopted at the time of the erection of this bridge, from the inquiries then commenced respecting them, that the ordinate in the middle of the arch, as well as the absciss, would have been whole numbers, and the same conclusion will be come to, if it had been a scheme as Ferroni supposes. But in adopting an ellipse for the curve, it may be presumed that the axes and the span would have been integers, and the height fractional, dependent on them.

In trying whether the curve be elliptical, we must assume one of the axes. It is a reasonable presumption to conclude from the obtuseness of the angle at the intersection of the arcs, that the semi-conjugate axis was taken, the next greatest whole number to $\overset{\text{B.}}{7}\ \overset{\text{S.}}{16}\ \overset{\text{D.}}{6}$, the ordinate in the middle of the arch, that is, eight braccia. Let $x =$ the absciss, $y =$ the corresponding ordinate, $c =$ the semi-conjugate, and $t =$ the semi-transverse. Then by the common formula $t = \dfrac{cx}{y^2}\left\{c + \sqrt{(c^2 - y^2)}\right\} = 32$ nearly. Hence we derive an ellipse whose semi-conjugate axis is $\frac{8}{64} = \frac{1}{8}$th of the transverse axis *.

If now we take $t = 32$ braccia, and $c = 8$ braccia, and then by the common formula $y = \dfrac{c}{t}\sqrt{(2xt - x^2)}$ we may obtain ordinates by calculation to compare with Salvetti's.

When $x = 2$, then y by calculation, $=$ 2 15 9, by measurement, 2 19 2,
5 . . . . 4 5 10, ... 4 7 1,
9 . . . . 5 11 2, ... 5 11 4,
10 . . . . 5 16 1, ... 5 15 10,

---

* Ferroni lays great stress upon Ammanati's prepossession for dimensions of which 8 is an aliquot part.

When $x = 12$ then y by calculation, $=$ 6 5 0, by measurement, 6 4 4,
15 . . . . 6 15 6, . . . 6 15 2,
17 . . . . 7 1 3, . . . 7 1 3,
20 . . . . 7 8 4, . . . 7 8 9,
25 . . . . 7 16 1, . . . 7 16 6,

By referring to the mode of framing the centering according to the drawing left by Parigi, it will be observed that the strutts abut against King posts, and not against each other as they should have done; and by supposing, as happened lately in this metropolis in a similar case, that the masons proceeded to lay the voussoirs from the imposts towards the key, without balancing by weights, the other parts of the centering, the little variation, (too small to be seen to the scale of the diagram, Fig. 1,) elicited by comparing these results, may be satisfactorily accounted for.

These dimensions shew that the arch has sunk at the haunches between the ordinates 9 and 20, and risen at the springing and crown, presuming the curve to be elliptical as deduced. It may be concluded, upon a balance of evidence, notwithstanding the approximation of the present curve of the middle arch to a catenary, that the curve was intended to be an arc of an ellipse, whose transverse axis is 64 braccia in length, and whose semiconjugate is 8 braccia. The properties of the ellipse, necessary to the setting out an elliptical rib, during the time the vaults of ecclesiastical buildings were erected, were as familiar to the commonest mason, as they are to every millwright by the practice of his trade. Mr. Rennie has, by the adoption of the conic section at Waterloo Bridge, probably by the accident of his early habits and extensive business as a millwright, made a great stride beyond his contemporaries, and acquired much honour for himself and his country, and availing himself of the lavish means afforded, he has maintained the unities of dress and form, without requiring a veil like Ammanati, or a skreen like Sir C. Wren.

The principal dimensions of this bridge are written on the small drawing of it, (Fig. 2,) in Florentine braccia, taken from Ferroni. It remains to be observed that the depth of the archivolt was intended to be, according to Parigí, one braccio and a half, that the depth of the arch at the crown was intended to be one braccio and a quarter, the span of the middle arch was intended to be, as it is, viz., 50 braccia, and of each side arch was intended to be 45 braccia. The radius of curvature $= \frac{c^4 + 4\,\overline{t^2 - c^2}\;y^2)\,^{\frac{3}{2}}}{2\,t\,c^4}$ = 120 braccia at the vertex of a pointed elliptical arch, the ordinate $= y = \overset{B.}{7}\ \overset{S.}{16}\ \overset{D.}{6}$, the transverse $= t = 64$, and the conjugate $= c = 16$; so that this arch ranks with a pointed arch, (the angle of intersection of the arcs as after shewn, being = 173° 34′,) composed of two arcs of a circle whose radius would be (120 × 1.9 =) 228 feet English, and the span (456 − 26 in whole numbers, the chord of an arch of the same circle of 6° 26′, =) 430 feet, the thickness at the vertex being $\left(\frac{240 \times 4}{5} = \frac{960}{5}\right)$ the 192nd part of the diameter of such circle. The angle made by the curve with its ordinate at any point, may be obtained as follows: let s denote the subtangent, and y and x as before, and t = the semi-transverse, then by the known formula, $s = \frac{2\,t\,x - x^2}{t - x}$, and by trigonometry, the tangent of the angle $= \frac{s}{y}$, which in the case of the vertex, gives by a table of natural tangents, the angle 86° 47′, or the angle made by the intersection of the two arcs, 173° 34′. Ferroni makes it for his scheme, 174° 4′. In the case of a catenary, the angle would be 169° 22′. Ferroni gives only the middle ordinate $= \overset{B.}{7}\ \overset{S.}{3}\ \overset{D.}{5}$, of one of the side arches and the spans of them; he has not invented a scheme to fit the curves. By referring to the ordinates given by him of the middle arch, it appears that the curves of the side arches must be arcs of an ellipse, (assuming the curves elliptical,) of which the semi-conjugate axis bears a less proportion to the transverse axis, than in the case of the middle arch. If we take again $c = 8$, and $x = 22\frac{1}{2}$, as intended by Ammanati, we have the semi-transverse $= t = \frac{c\,x}{y^2}\left\{c + \surd\,(c^2 - y^2)\right\} = 40$. Hence we derive an ellipse whose semi-conjugate axis is $\frac{8}{80} = \frac{1}{10}$th of the transverse axis; from which we may obtain the ordinates by construction by Fig. 1, or by calculation as before; the angle formed by the intersection of the curves at the vertices of the side arches, will be 169°, 44′, according to the formulæ before given.

Fig. 3. The semi-span of the pointed circular arch in the case of the middle arch from which the elliptical arch would be an elongation (when r = the radius = 8, and the height = c = $\overset{\text{B.}}{7}\ \overset{\text{S.}}{16}\ \overset{\text{D.}}{6}$,) will be $= r - \sqrt{r^2 - c^2} = \overset{\text{B.}}{6}\ \overset{\text{S.}}{6}\ \overset{\text{D.}}{8}$.

Fig. 4. In the case of the side arches, the semi-span will be $\overset{\text{B.}}{4}\ \overset{\text{S.}}{9}\ \overset{\text{D.}}{1}$, the height being $\overset{\text{B.}}{7}\ \overset{\text{S.}}{3}\ \overset{\text{D.}}{5}$.

ART. II. *A History of a painful and obstinate Affection of the Brain, which ultimately yielded to the unremitting Application of Cold, and the continued erect Position for a week.* *By* G. D. YEATS, M.D., F.R.S., Fellow of the Royal College of Physicians, &c.

[In a Letter to the Editor.]

DEAR SIR,

I request the insertion of the following case in your Journal. It illustrates, in a clear point of view, the good practical effect of the application of cold, assisted by position, in obviating and ultimately curing the painful and dangerous consequences of congestion of blood within the cranium, after the failure of other very active means; and this morbid condition of the brain succeeded to, and was connected with, a long-continued irritation in the digestive organs.

I am, dear Sir,
Yours faithfully,
G. D. YEATS.

17, *Queen-street,*
May Fair, Feb. 16, 1823.

I was consulted by H—— J——, Esq., aged 40, on the 14th February, 1819. He complained of general uneasiness, not easily defined, in the region of the stomach, with a languid and sinking feel there. The tongue exhibited that furred and clammy appearance common in disturbed digestion; the appetite was not impaired, but he felt uneasy after his meals, which induced him to indulge in wine at dinner, as the stimulus of it gave temporary relief; he was troubled with frequent headachs. The bowels were costive, and very irregular in their movements, a properly-figured evacuation being seldom passed, and the passing the contents of the intestines caused uneasy sensations of fulness about the head; the fæces were likewise very morbid in appearance. The urine was not much altered in quality or quantity; the pulse did not particularly indicate disease. On examining the abdomen, no fulness was perceptible, but a soreness was complained of, and some hardness felt on pressure on the right side, in the region of the liver. He had become considerably thinner, and had suffered from the above complaints for a long time, and had taken the advice of several professional gentlemen. By attending to the condition of the lower intestines and digestive organs, with the proper evacuants and alteratives, more comfortable sensations were acquired there; but the head now principally arrested attention on account of the great uneasiness complained of in it, which rendered it necessary to have recourse to the local detraction of blood, and to a constant soluble state of the bowels, by *cooling* laxatives, and a restricted diet. He left town in March, on professional business at Cambridge.

May 5.—Up to this day I had seen Mr. J——— two or three times after his return to town. He had been cupped, and bled, and blistered, before and since I saw him, and his bowels had been attended to by evacuants, with very little relief to the affection of the head, beyond some temporary ease, and sometimes without this. At this date, May 5, 1819, the affection of the head had evidently increased; the pulse had become somewhat quicker and harder, and he described the distress in his head in the following manner:—A pain, with heat, would commence in the back part of it, deep seated, and would be diffused gradually throughout the whole of the back part of the brain, which would continue sometimes for two hours, causing insufferable distress within the scull, but confined, as it would seem, to the cerebellum, as the crown and fore-part of the head were not affected. A horizontal position increased this suffering, and it was most acute about three or four o'clock in the morning, after he had slept for some hours. He felt considerable giddiness and confusion in his head when he stooped upon any occasion. The symptoms evidently indicated bleeding, but he would not submit to it in any way, from the failure of these means to procure relief on former occasions. His sufferings and his danger, too, being now greatly multiplied, he submitted, after much persuasion, to the following plan:

At my request a seton was inserted in the neck, by Sir Astley Cooper. Mr. J. was confined entirely to vegetable and farinaceous food; barley-water, rennet whey, and such like, being his only beverage, and he was desired to keep *continually* in the erect position with his body, by sitting in a chair, not going to bed at all, and to keep his head, which had been shaved for the purpose, *unremittingly* moistened with a cold lotion (a solution of muriate of ammonia, in vinegar and water). I put him upon this plan from the idea that the blood did not readily find an exit from the head, in the tortuous and complex circulation of the brain, in the horizontal position; and, 2dly, the veins of the brain had become weakened, from the long state of distention in which they had existed; they had not, therefore, sufficient power to propel their contents against gravity, while the body was in the recumbent position, which, at the same time, favoured the transmission of the blood to the head by the arteries; thus there was a supply, without a corresponding discharge. The erect position facilitated the return of blood from the head, while it assisted to impede its progress thither, and the coldness of the lotion gave a contractile power to the veins, diminished their calibre, thus accelerated the transit of the returning blood, and prevented the accumulation and the consequent pain.

The happy practical effect fully confirmed the soundness of the doctrine. From the ease which this plan very speedily produced, Mr. J. very readily submitted to a perseverance in it, and for one whole week he never once lay in a horizontal position, and the application of the lotion to the head was never omitted during the whole of that time. He occasionally walked about the room for relief. At the end of the week he was so much *better* that the plan was gradually omitted; and the best symptom of amendment was, that he was able to sleep horizontally, awaking without pain. I am well aware of the excellent effects of the application of cold in that excited state of the brain, which in children and others so often ends in effusion of fluid there, but I do not recollect to have met with so long continued and obstinate a pain within the head, connected, too, with such great derangement in the digestive organs, in which the erect position, with cold applications, was so long persevered in, and with such decided and permanent benefit. The seton was not withdrawn till the 6th of July, a period of two months from its first insertion. The only medicines taken were, a solution of the supertartrate of potash as a diuretic (to obviate the accumulation of fluid in the brain, for in almost all cases of severe affections of this organ, more or less of effusion of fluid takes place,) and occasional purgatives when necessary. This gentleman remained free from his complaint up to last year, since which time I have not heard of him.

ART. III. *An Account of the Rock Specimens collected by* CAPTAIN PARRY, *during the Northern Voyage of Discovery, performed in the Years* 1819 *and* 1820. *By* CHARLES KONIG, ESQ., F.R.S., *&c.*

[*To the* EDITOR *of the Quarterly Journal of Science and the Arts.*]

British Museum.
Feb. 18th, 1823.

MY DEAR SIR,

I have great pleasure in transmitting to you the short account I have been desired to write of the rock specimens, which were collected during the voyage performed by Captain Parry in the years 1819-20. It was drawn up from rather slender materials, immediately after the return of the Expedition. Although I am fully sensible of the little value of desultory remarks made under such circumstances, yet I think that the interest, inseparable from every the smallest communication connected with those most important investigations, that have been and are still carrying on in the polar seas by that enterprising navigator, will plead your apology as well as mine, for submitting them to the readers of the Journal of Science.

We may conclude, from the nature of the rock specimens collected on the former voyage for discovering the North-West Passage, that both the east and west coast of Davis' Strait and Baffin's Bay are composed of primitive formations, in connexion with others of a more recent date, which for the greatest part belong to several members of Werner's trap formation. It would appear, however, from the paucity of specimens decidedly referable to trap rocks among those brought from Baffin's Bay by the late Expedition to the Arctic Seas, that the same formation is less prevalent on the western coast. While on the west coast of Greenland it exists in all its different gradations, but more particularly in the form of amygdaloidal transition trap, with many of those minerals which are usually found nidulating in it, such as calcedony, agate, jasper, green earth, *&c.*, no traces of any of these substances are seen among the specimens collected by the Expedition in its progress down the western coast of Baffin's Bay, where the principal rocks are gneiss and micaceous quartz-rock, with some ambiguous granitic compound, in which hornblende seems to enter as a subordinate ingredient.

In the latitude of the entrance into Sir John Lancaster's Sound, the specimens which I had an opportunity of seeing, begin to indicate the predominance of older traps, with other concomitant transition rocks. Among them the more prominent are fragments (many indeed only detached from boulders,) of well-defined syenite, with red, and others with greenish-grey feldspar, the latter approaching to compact in its texture. Epidote, which is frequently seen in this syenite, has in some specimens the appearance of being one of the constituent ingredients of the rock. Other masses from Possession Bay, are hornblende rock, with disseminated garnets; greenstone, apparently primitive, and a greenish grey sandstone more or less impregnated with oxide of iron. There are a few other varieties of sandstone, one of which, more or less streaked with reddish-brown, has all the characters of and may possibly belong to the *bunt-sandstein* of Werner; especially as there are accompanying specimens of fibrous and fletz-gypsum, which formation is generally found with and resting upon the second or variegated sandstone, and is often overlaid by shell limestone. Of this last-mentioned variety of fletz limestone, there is a specimen among those collected in the valley of Possession Bay, by Mr. Fisher. This gentleman, it is observed, found that valley to consist partly of basalt; but I have not seen any specimens of this rock among the fragments obtained in that place. The other rocks from that quarter which have fallen under my observation, are chiefly primitive, *viz.*, granite, gneiss, and some mica slate, with hornblende and quartz rock. They exhibit nothing new or remarkable in their oryctognostic character. The several varieties of granite differ from each other only in the varying proportion of the usual component parts, in their grain and colour. Both the gneiss and mica slate contain small imbedded garnets, and to the latter of these may be referred a micaceous mass, enclosing grains and amorphous masses of noble garnet, intermixed with a yellowish white substance, which seems to be compact feldspar. Another substance from Possession Bay which deserves to be noticed, is a variety of fibrous limestone, not inferior in lustre, when polished, to the satin spar of Cumberland.

Compared with these rock specimens from the western coast of Baffin's Bay, those gathered on the coasts where Captain Parry's discoveries commenced, seem to indicate a considerable difference in the respective geological features of those tracts. The north coast of Barrow's Strait, as far westward as the Polar Sea, and part of the eastern coast of Prince Regent's Inlet, appear to exhibit a character belonging to those more recent formations which are known to proceed from the primitive mountains of Scandinavia, and other explored tracts of high northern latitudes. Among them a variety of limestone seems to prevail, which is very like the Alpine or mountain limestone. It is compact, of yellowish and greyish colour, and contains, among other remains of zoophytes and shells, abundance of the same species of Terebratula, which are characteristic of that rock in various alpine tracts in Europe. A greyish-brown fetid variety of limestone, from the north side of Barrow's Strait, bears great resemblance to the mountain limestone as it occurs in Derbyshire; it contains parts of corallines, which are, however, too imperfect to be determined. The chert, or hornstone, of which likewise specimens were found in those parts, may, perhaps, occur as subordinate beds in this transition limestone. Among the specimens from Riley Bay, is a fragment of white granular marble passing into compact.

Not less indicative of the formation to which the above-mentioned varieties of limestone belong is a calcareous mass, which, it would seem, abounds in various parts of the north coast of Barrow's Strait, on the eastern coast of Prince Regent's Inlet, and which also occurs on the south coast of North Georgia. This limestone, which bears some resemblance to that of Gothland, in which parts of the stems of Encrini are found, is yet sufficiently distinct from this, and all other varieties I am acquainted with, to deserve being briefly noticed in this place.

It is of a yellowish-white colour, and, in most hand specimens, exhibits a uniform coarse-granular structure; it is friable, and the grains are indeterminately angular, more or less shining, and sometimes intermixed with, or cemented by, calcareous matter of a deeper yellow. Reduced to powder, it emits a yellow phosphorescent light when strewed on a heated iron. This calcareous rock, in some specimens from Prince Regent's Inlet, abounds with parts of the jointed stem and single joints of a zoophyte belonging to the natural order of Encrini; other specimens appear to be entirely without these bodies: but on subjecting the different varieties of aggregation to a closer examination, it will be found that those which contain no remains manifestly belonging to the just mentioned organized fossil bodies, are, nevertheless, entirely composed of their *detritus*. This encrinitic mass, in single specimens, might readily be mistaken for a friable variety of common granular limestone, did not a comparison of a series of specimens prove that appearance to be produced by the extreme comminution of the substance of those fossil zoophytes, each particle of which still exhibits planes of cleavage parallel to the primitive rhombohedron.

The joints of the stem and branches of the zoophyte which appears to have thus largely contributed to the formation of this mass, are mostly cylindrical; their thickness is in an inverted ratio with that of the column of which they form parts; those near the body being the largest and thinnest. Cylindrical portions of the stem, formed by these thinner vertebræ, exhibit on their surface hemispheric concavities, some of them large enough to occupy from four to six of the thin joints or vertebræ, the lines of separation of which are seen to traverse the cavities in a horizontal direction. They are the sockets of articulation, in which the branches of the stem were inserted. The casts produced from these concavities in the surrounding mass, might, when seen without their moulds, be easily mistaken for distinct organic remains. There is little doubt that this zoophyte is related to some of those encrinites of which parts of the stem and branches so frequently occur in the transition limestone of Gothland. It seems to me also probable that many of the screw stones (Epitonium, L.) owe their origin to the decomposition of the stems of species belonging to this genus.

Another species of a genus of zoophytes, peculiar to the transition limestone, was found by Captain Parry, in Prince Regent's Inlet, at the foot of a high hill. It is a fine Catenipora, which appears to be quite distinct from the common chain coral of Gothland, and other countries. Lamarck has two species of this genus, namely, the common one, which is (rather unaptly) called by him *C. escharoides*; and another, which he distinguishes by the name of *C. axillaris*, though it appears from his reference to a figure in the *Amœnitates Academicæ,* that he is speaking of TUBIPORA *serpens, L.*, which is not a congener of, and can indeed scarcely be considered as belonging to the same natural order with Catenipora. We may, therefore, look upon this arctic species as an undescribed and anonymous one. I call it

CATENIPORA *Parrii:* tubulis crassiusculis, compressis, collectis in laminas sinuatas varie inter sese coalitas, tubulorum orificiis ovatis sæpe confluentibus: dissepimentis confertissimis.

The space between the laminæ is filled up by a yellowish calcareous mass; the tubes themselves are converted into carbonate of lime, internally drused with minute crystals of the same substance.

Very little can be inferred from the specimens of primitive rocks, gathered both in Prince Regent's Inlet and Barrow's Strait: they are, for the most part, fragments from rolled pieces, and consist chiefly of granite, mica slate, and quartz rock. There are, nevertheless, some among them, especially among those from the first-mentioned tract, which distinctly indicate primitive trap formation, such as granular and slate hornblende rock, together with several varieties of syenite, and similar rocks, in which hornblende and felspar form the predominating ingredients; some of them enclosing massive and indistinctly crystallized epidote of either a yellowish or grass-green colour. Among some specimens found at Port Bowen, on the eastern coast of Prince Regent's Inlet, may be specified a rolled piece of a mass, composed of flesh-red felspar, greyish-white quartz, and a substance which is distinct from epidote, though it might easily be mistaken for it. According to an analysis, with which I have been favoured by J. G. Children, Esq., it is composed of silica 59.89, alumina 22.45, soda 6.84, lime 4.85, oxide of iron 4.0, magnesia 0.67, oxide of manganese 0.16;—loss 1.14. Its specific gravity Mr. Children found to be 2.67. Before the blow-pipe it melts into a milk-white enamel. Its colour is a dirty yellowish green, passing into brownish. It is scratched by the knife; streak white. Fracture uneven, dull, approaching to resinous; here and there with small planes of cleavage, which are shining, and even splendent. It is rather easily frangible; the fragments are indeterminately angular, and translucent at the edges. This substance, which I suppose constitutes a distinct species among the silicates of sodium, appears to be one of those which enter the composition of the rock called Gabbro by Mr. Von Buch.

As probably connected with this formation we may consider the magnetic iron-stone, of which some specimens were gathered in lat. 72° 45′, long. 90° west; it is of a very fine grain, and occurs also disseminated in, and alternating with, granular quartz, exhibiting white and grey stripes. Some specimens also of jaspery ironstone mixed with particles of quartz, were found on the eastern coast of Prince Regent's Inlet. Nor is the presence of iron less observable in specimens referable to more recent formations of trap from the same quarter, such as various kinds of clay ironstone, and ferruginous sandstone. Of the latter of these a greenish-grey variety appears to be of particularly frequent occurrence in those parts; if we are allowed to judge from the many, especially tabular, fragments brought from thence, which are all, more or less, impregnated with brown hydrous oxide of iron, some being so completely penetrated by it that they may be considered as tolerably rich ores of this metal.

As it is sufficiently difficult to judge of the relative antiquity of depositions of sandstone, when observed *in situ*, it would, of course, be altogether unavailing to indulge in conjectures respecting the formations to which the fragments and rolled pieces may have belonged, which were picked up in various parts of the north coast of Barrow's Strait, and Prince Regent's Inlet. The most abundant among them is a red sandstone, and a variegated one with brownish-red stripes. These varieties are seen to pass into one another: they are composed of small grains, united by a quartzy cement, and frequently confluent, so as to form a nearly compact, hornstone-like mass, similar to the variety of hard sandstone from Egypt, which has been often employed in that country for purposes of statuary and architecture. In external characters it agrees exactly with one of the oldest formations of fletz sandstone, the *bunt-sandstein* of Werner; and the slaty grey sandstone, of which specimens were found, may possibly be the *sandstein-schiefer* of the same geologist, which is said to be a characteristic concomitant of this second sandstone.

There is nothing particularly remarkable in the specimens from Byam Martin's Island: they are few in number, consisting of two varieties of granite, both with bright-red feldspar, red close-grained sandstone passing into compact, and a ferruginous sandstone, together with small fragments of flint slate.

The rock specimens from Melville Island, though little can be said respecting the relative situation of most of them (they being chiefly rolled pieces, or casual fragments,) yet form a more complete series than the others, and some of them are by no means uninteresting. There are two or three varieties of granite, gneiss, and syenite; the latter (from Winter Harbour, and the north shore of the island,) of a larger grain and with red feldspar, contains much green epidote, and is very like that which occurs in several parts of the island of Jersey*. In another variety from Winter Harbour, which contains some disseminated iron pyrites, the hornblende appears in a more compact state, and in the shape of irregular veins and threads. Another variety from the same place is rather remarkable from its exhibiting here and there small cavities, drused by minute quartz crystals, and coated by scaly red ironstone. In another specimen, small grains of ironstone, attracted by the magnet, were seen, and, upon examination, found to be titaniferous. The few pieces of hornblende rock from this island, seem to be detached from boulders found in Winter Harbour; among them is also a specimen of a slaty compound of hornblende, mica, and red feldspar.

The principal formation of the island appears to be the fletz sandstone, with the subordinate one of coal and ironstone. The structure of the cliffs along a considerable extent of the northern shore of Barrow's Strait, exhibiting, beside horizontal stratification, numerous buttress-like projections and mural precipices, is not of uncommon occurrence in the formations of the transition and older fletz lime stone; but still more striking in this respect is the appearance of the sandstone formations, especially those of more ancient date. Having undergone a peculiar disintegration which acts in a direction nearly perpendicular to the horizontal stratification, they exhibit the representations of ruined towers, buttresses, pillars, and similar works raised by the hand of men. This structure, so strikingly expressed in the sandstone formation of Bohemia, Saxony, and other parts of Germany, at the Cape of Good Hope, and particularly in several mountainous tracts of China, appears no less characteristic of the sandstone of some parts of the coast of Melville Island, especially at Cape Dundas, the westernmost point to which the investigation of Captain Parry extended, and the general features of which have been so ably described by him in his Journal.

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* See my description of it in Plees's *Account of Jersey*, p. 233.

This sandstone is composed of very fine, flat, confluent grains, with here and there the appearance of minute silvery scales, which, when more or less aggregate, communicate to the mass a perfectly micaceous appearance. It occurs both of a uniform greyish-white colour, and more or less marked throughout by small brown ochry spots, which sometimes are confluent into large patches. It generally separates into tabular pieces, and is sometimes invested on the rifts with thin plates of white carbonate of lime. Some of its varieties are not unlike grauwacke slate. It contains secondary fossils. Of the specimens which I had an opportunity of examining, two bore the impressions of a Trilobite, but too indistinct to admit of being determined with precision *.

In another variety of sandstone, of a grey colour, found in the neighbourhood of Table-hill, I observed some disk-shaped bodies of about half an inch in diameter, exhibiting concentric circles, with crenulated rays proceeding from the centre, which

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* I have since determined it to belong to Brongnart's genus of ASAPHUS lately published; but whether or not it be one of the species described by him and Wahlenberg, cannot be ascertained from the specimen alluded to.

is in the form of a small knob: they are, no doubt, trochi or joints of the stem of an Encrinus; but this is all that can be said of them.

The two specimens of sand stone containing the above-mentioned secondary fossils, are pretty similar in appearance to those others brought from Melville Island, which abound with the vegetable remains characteristic of the coal sandstone. These are for the most part merely impressions and filmy carbonaceous remnants of leaves (or fronds with ovate-lanceolate leaflets,) and stems, which by their regularly placed oval marks, indicate that the prototypes belonged to the arborescent ferns which we observe in such great abundance in the coal sandstone of more southern latitudes; a proof that the inhospitable hyperborean region where they occur, at one time displayed the noble scene of a luxuriant and stately vegetation. There is also among the specimens of sandstone from the same place, one bearing the impression of a thin, longitudinally-striated stem, not unlike that of some reed.

The coal itself is of a more or less slaty-structure, and approaches, in some specimens, to the nature of brown coal; its colour is of a brownish black: it is easily cleft, and the planes of separation, which are without lustre, exhibit here and there black shining spots, and lines apparently of a bituminous nature. It emits no unpleasant smell when burning, and leaves copious greyish-white ashes. This coal is not the same with that of Disco Island, which contains the amber; it differs from it both in colour and structure. There is a piece of fine pitch coal or jet among the objects picked up in the neighbourhood of Cape Hearne.

Part of the specimens of argillaceous and brown ironstone, found in Melville Island, evidently belong to the same formation as the sandstone so abundant in these parts, and are alike concomitants of the coal. They consist chiefly of rounded pieces, and likewise of geodes: the former appear also to exist here in the shape of a conglomerate. Some specimens from Table-hill and its neighbourhood, as also from Liddon's Gulf, are marked with the impressions of bivalves, particularly of a small, flat, ovate cuneiform species of mytilus. One of the fragments of compact brown iron stone exhibits a glossy surface and fracture, approaching to fibrous.

There are also specimens of sandstone which exhibit a transition into a kind of brown ironstone: in this state it is generally seen as tabular pieces, similar to that which in some parts of Norway, *&c.*, is deposited in beds of a few inches' thickness in sandstone, into which it passes.

In the same manner the hydrous oxyde of iron is seen to penetrate clay which here and there slightly effervesces with acids, and is therefore a ferruginous marl.

There are a few varieties of slate-clay, such as might be expected to occur with coal and sandstone formations: they are very soft, of ash-grey, and greenish-grey colour, and were found overlaid by sandstone at the bottom of ravines.

The limestone from Melville Island, especially that from Table-hill, bears the character belonging to that of the oldest *fletz* or transition formation. The secondary fossils which it contains are chiefly bivalve shells and corallines. None of these, however, are perfect enough to admit of the determination of the genera to which they respectively belong, except a small species of Terebratula of that division which comprehends the Petunculi of earlier writers on petrifactions, and a species of Favosites, which does not appear to differ from *F. Gothlandicus.*

There are a few specimens among those from Winter Harbour and Table-hill, which appear to bespeak the presence of fletz trap-rocks in Melville Island; but being found as rolled stones, they do not allow any judgment being formed of the relation in which they stand to the other formations. I have seen from those parts a few small fragments of calcedony, with opaque stripes like the onyx from Iceland and Ferroe; fragments of red jasper, and of a jaspery breccia; a piece of a compact hornstone-like mass of greenish colour mixed with reddish, and small rolled pieces of basalt. There is also among them a specimen of wood-hornstone of greyish-brown colour, with concentric yellowish-white rings. Nor should I omit mentioning a similar specimen of wood stone from Byam Martin's Island, with numerous close concentric rings, the curve of which indicates its being a fragment of the stem of a petrified dicotyledonous tree. It is susceptible of taking a beautiful polish.

I remain, my dear Sir, with great regard,
Very sincerely yours,
CHARLES KONIG.

ART. IV. *On the Influence of Local Attraction upon the Magnetic Needle, by* MR. JOHN MACNEILL.

[In a letter to the Editor.]

[Mr. Macneill has obligingly forwarded us a map of the district alluded to in the following communication, but as the subject is sufficiently intelligible without it, we have not thought it necessary to delay the publication of the paper.]

SIR, *Mount Pleasant, January 20th,* 1823.

IN the progress of a trigonometrical survey, in which I am now engaged, of the County Louth in Ireland, I have frequently observed instances of a local attraction, by which the magnetic needle is considerably affected; the most remarkable instance of this I observed in the beginning of this month, on the South side of the range of mountains which runs from Newry to Carlingford, and not more than two miles north of Dundalk; this range is here broken into deep glens, bordered by conical and detached hills. One of these, which appears especially to cause a deviation in the needle, is not of so considerable an elevation as many of its neighbours, but rises conically on the side of the principal range: its surface is rocky and uneven, with very little freestone towards the south and south-west; I have sent you a small specimen of the stone of which it appears to be composed, and which affects the magnetic needle very powerfully; the principal object I had in view in observing the deviation of the needle in the different parts of this county, was to exhibit on my map such districts as could not be surveyed by the needle, for I am sorry to say, that the old and imperfect instrument the circumferenter, still continues to be used by land surveyors, with very few exceptions throughout the whole of this country; and as it must be evident, that any survey made by the needle in such a district as the one in question must be incorrect, I conceived it would not be unacceptable to many to have such information inserted in a county map. From a mean of ten observations of the sun, I found the variation of the needle from the true meridian to be 28° 9′ 41″ at the point C towards the west; at the point 9, a distance of 45 perches from the former, it was 29° 2′, and at 8, distant 38 perches from the last, it was 29° 40′; at the point 7, a distance of 20 perches, it was 30° 4′; at the point 6, a distance of 15 perches, it was 31° 40′; at the point 5, a distance of 28 perches, it was 32° 45′; at 4, it was 31° 37′, the distance 41 perches; at 3, it was 30° 1′, the distance 20 perches; at 2, it was 29° 7′, the distance 29 perches; and at the point 1, it was 28° 10′; at which it has again become very nearly the true annual variation of the year: the lines D, 1, 2, 3, &c., are the magnetic meridian, and the red lines shew the deviation of the needle at those points. I have taken the liberty of forwarding you the above trifling remarks, which perhaps you may think worthy of some notice in your valuable and useful publication.

I have the honour to be, Sir,
With respect, your obedient servant,
JOHN MACNEILL.

ART. V. LAMARCK's *Genera of Shells.*

(Continued from Vol. XIV. p. 322.)

9th Family.

NAIADA*. (4 Genera.)

Fresh water shells. Hinge sometimes with an irregular, simple, or divided cardinal tooth, and a longitudinal tooth extending under the corselet; sometimes no tooth, or is furnished, through its whole length with irregular, granular tubercles. Muscular impression posterior, compound. Beaks decorticate, often eroded.

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* River Nymphs.

The Naiada are well distinguished from the fresh water conchæ by their hinge, and the animal inhabitant. The shell is free, regular, equivalve, inequilateral, always transverse; the epidermis is greenish, inclining to brown, and is always wanting at the beak. The muscular impressions are lateral, and quite separate; that of the posterior side is composed of two or three distinct or unequal impressions, which distinguishes them from the other bimuscular conchifera.

The animal has no projecting syphon or tube; its foot is lamellar, transversely elongated, and rounded, which it protrudes beyond the valves, and uses for locomotion. It generally remains partly buried in the mud, with the beaks immersed.

1. Unio*.

Shell transverse, equivalve, inequilateral, free; beaks decorticate, almost eroded. Muscular impression posterior, compound. Hinge with two teeth on each valve; one, cardinal, short, irregular, simple, or bifid, substriated; the other elongated, compressed, lateral, channelled, extending under the corselet, for a considerable space along the lower margin on that side. Ligament external.

Linnæus confounded the Unio with the Mya, although the latter is a sea shell, and very different in form, hinge, position of the ligament, and the animal which inhabits it.

The Unio is eminently distinguished from the Anodonta, (which it resembles externally,) by its hinge. Each valve has a short cardinal tooth, that on the left valve generally simple, that on the right divided into two lobes, besides a lateral tooth, as described above. The two teeth of each valve articulate together when the valves are shut. The shell of the Unio is formed in general, of a very brilliant mother-of-pearl; externally, it is covered with a greenish or brown epidermis, except on the beaks, which are decorticate, and more or less carious. Lastly, the lamina of the margin of the shell, above the lateral tooth, has a truncation or sinus, which seems to receive a portion of the ligament. The Uniones live buried in the mud, in rivers, with the beaks downwards, and many of them produce tolerably fine pearls. Several are slightly gaping.

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* A pearl called an Union, from *unus*, because no two, found in the same shell, are alike.

This genus is subdivided into (1) shells with the cardinal tooth short, thick, not crested, (*en crête*) and substriated, 30 species; and (2) cardinal tooth short, flattened, prominent, and often crested,—18 species.

Type. *Unio sinuata*[*]. (Mya margaritifera ? *Linn.*)

Shell ovate-oblong, compressed, sinuous, on the upper part thick; nates rather prominent; cardinal tooth thick, lobed, striated. *Rivers of the European Continent.* In all 48 species. Pl. I. Fig. 69.

2. Hyria[†].

Shell equivalve, obliquely triangular, auriculated; base truncated and straight. Hinge with two low teeth; one, posterior or cardinal, divided into numerous diverging parts, of which the interior are the smallest; the other, anterior or lateral, very long, and lamellar. Ligament external, linear. The Hyria is distinguished from the Unio, by its general form, and by the cardinal tooth, particularly that on the right valve, which is divided into numerous lamellar folds, the innermost very small, and has the appearance of a bundle of very unequal, diverging laminæ. This compound tooth is rather depressed than prominent, and always inclines towards the posterior side of the shell, instead of rising perpendicularly to the plane of the valve.

Type. *Hyria avicularis*[‡]. (Mya Syrmatophora ? *Gmel.*)

Shell with umbones and nates smooth; ears large, produced to a point, subacute. Brazil ? 2 species. Pl. I. Fig. 70.

3. Anodonta[§].

Shell equivalve, inequilateral, transverse. Hinge linear, without teeth. Base of the shell terminated by a smooth cardinal lamina, truncated or forming a sinus at its anterior extermity. Two distant muscular impressions, lateral, subgeminal. Ligament linear, external, its anterior extremity inserted in the sinus of the cardinal lamina.

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[*] *Sinuous.*

[†] Υριον, a *honeycomb*—alluding, we suppose, to the form of the cardinal tooth.

[‡] Allied to the *avicula*.

[§] Ανοδυς, from *α*, *not*, and *οδυς*, a *tooth*, having no teeth.

The anodontæ, which Linnæus confounded with the Mytili, are fresh water shells, usually very thin, and often of a large size. They greatly resemble the Uniones, but have neither cardinal nor lateral tooth, the hinge presenting merely a smooth interior margin, or lamina, situated immediately below the nymphæ, and terminated anteriorly by a truncation or sinus. The shell is nacreous, and covered externally with a thin, greenish, false epidermis; beaks decorticate, oblique, partly inclining to the posterior margin. The animal has two short tubular apertures, formed by the posterior extremity of the mantle, and furnished with little tentacular threads. It has no byssus; it has a very large, almost round, compressed muscular foot, which it uses for locomotion. It is hermaphrodite, and seems to be viviparous, for the ova pass between the branchiæ, where the young are found with their shell perfectly formed.

The species are subdivided into (1) shells without any distinct angle at the posterior extremity of the cardinal line, 10 species; and (2) those which are distinctly angular at that part, 5 species.

Type. *Anodonta Cygneus**. (Mytilus cygneus, *Linn.*) Shell ovate, brittle, posteriorly dilated, rounded; with unequal transverse furrows; nates obtuse. *Lakes, &c of Europe.* In all 15 species. Pl. I. Fig. 71.

4. Iridina†.

Shell equivalve, inequilateral, transverse; beaks small, slightly curved, almost straight. Muscular impressions as in the Anodonta. Hinge long, linear, attenuated towards the middle, tubercular through its whole extent, almost crenate; tubercles unequal, frequent. Ligament external, marginal.

The principal difference between the Anodonta and Iridina, consists in the tuberculated hinge of the latter, in other respects they are very similar. The shell is rather thick, brilliant pearly, reddish, especially internally, and iridescent.

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* From *cygnus*, a *swan*.

† From *iris*, a *rainbow*.

One species. *Iridina exotica*[*].

Shell transversely oblong, longitudinally striated; striæ very delicate; lateral edges rounded; beaks slightly projecting above the hinge. *Rivers of Hot Climates.* Pl. I. Fig. 72.

10th. Family.

CHAMACEA. (3 Genera.)

Shell inequivalve, irregular, fixed. Hinge with one thick tooth, or none at all. Two separate, lateral, muscular impressions.

The ligament of the shells belonging to this family is external, and sometimes sunk irregularly towards the interior; with respect to the hinge, they have some analogy to the tridacnea; they are often lamellar and spinous, their beaks always irregular, sometimes large and contorted. The animal has only short, disunited syphons. The shells are attached to rocks, corals, and often to each other.

1. Diceras[†].

Shell inequivalve, adhering; beaks conical, very large, diverging, irregularly spiral. One very large, thick, concave, subauricular, prominent tooth, in the largest valve. Two muscular impressions.

The diceras somewhat resembles the isocordia in external form, but it is more nearly allied to the chama, in which genus Bruguiere has included it. It differs from them, however, by its hinge, and the singular form of the beaks.

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[*] *Exotic.* We have given the characters of *I. exotica*, as being the only species described or named by Lamarck. Mr. Sowerby (*Genera of Recent and Fossil Shells*,) has a beautiful figure of another species, *I. elongata*; and Mr. Swainson, (*Phil. Mag.* lxi. 112,) has described three species, *viz.*, *I. striata*, *I. elongata*, and *I. ovata*. Our figure is taken from the single polished valve, in the British Museum, which Mr. Swainson thinks probably belongs to the last species, if properly to either of them. It was certainly a mistake, as he observes, to call it *I. exotica*. Mr. Swainson describes the *I. ovata*, as follows. "Shell smooth, transversely oval; umbones prominent and nearly medial."

[†] From δις and κεϱας, signifying with two horns?

Only one species. *Dicĕras arietinum*[*]. (Chama bicornis. *Brug.*)

Fossil, from Mont Salève. France, Pl. I. Fig. 73.

2. Chama[†].

Shell irregular, inequivalve, fixed; beaks curved, unequal. Hinge with only one thick, oblique, subcrenate tooth, fitting into a pit on the opposite valve. Two distant, lateral, muscular impressions. Ligament external, depressed.

In the genus chama Linnæus has included very dissimilar shells, uniting regular and equivalve shells with those that are irregular and inequivalve, and free shells with fixed. Bruguiere reformed this genus, which now consists of irregular, coarse, rough, scaly or spinous shells, with very unequal valves, and only one thick, oblique, transverse, callous tooth, usually crenate or furrowed. The beaks are curved inwards, and only one of them projects at the base of the shell.

The chamæ usually live in shallow salt water; they are always found attached to rocks, or corals, by the larger valve, or adhering together in various groups: except the scaly or lamellar species, they are seldom brilliantly coloured. This genus is subdivided into (1) shells, whose beaks turn from left to right, 10 species; and (2) those from right to left, 7 species.

Type. *Chama lazarus.* (Idem, *Linn.*)

Shell imbricate; lamellæ dilated, wavy-plicate, sublobate, obsoletely striated. *American Ocean.* In all, 17 recent species, and 8 fossil. Pl. I. Fig. 74.

3. Etheria[‡].

Shell irregular, inequivalve, adhering; beaks short, sunk, as it were, in the base of the valves. Hinge without teeth, wavy, subsinuous, unequal. Two distant, lateral, oblong muscular impressions. Ligament external, tortuous, partly penetrating the shell.

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[*] *Of, or belonging to, a ram.*

[†] *Chama*, the Latin name of a species of shell fish, said to be derived from χαινω, to *gape*.

[‡] One of the *oceanides*, or *sea-nymphs*.

The etheriæ are very rare shells, and little known, being attached to rocks at a considerable depth in the sea. They might be mistaken for ostreæ, from their irregular form, but they are allied to the chamæ by their separate, lateral, bimuscular impressions, and indeed are only distinguished from them, by having no tooth at the hinge; they are, however, much more pearly and brilliant than the chamæ internally, and their shell is perfectly foliated, like that of the ostreæ. Most of them are rather large, and all are attached by the lower valve.

This genus is subdivided into (1) shells having an oblong callus in the base of the shell, 2 species; and (2) those which have no such callus.

Type. *Etheria semilunata* *.

Shell obliquely ovate, semi-circular, rather gibbous; posterior side straight; nates conformable, nearly equal. *Indian Ocean?* In all 4 species. Pl. I. Fig. 75.

Second Order.

CONCHIFERA UNIMUSCULOSA†.

Only one muscle, which appears to pass through the body. Shell with one internal muscular impression, nearly in the centre.

The distinguishing characteristic of this order is the singular muscle by which the animal is attached to its shell, the impression of which, is generally discernible in each valve, sometimes very large and remarkable. The shell is generally irregular, inequivalve, and of a foliated texture; but, besides that these characters are not peculiar to the genera belonging to this order, since the same is nearly the case with the chamacea, they are not common to all of them; for some, as the pectines, &c., have a regular shell, without a distinctly-foliated texture, others, as the lingula, have their valves equal, or very nearly so.

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* *Crescent-shaped.* Lamarck's first species of the second subdivision. The shell, from which our figure is taken, was obligingly lent us by Mr. Sowerby. It is extremely difficult to determine the species of some of the irregular shells, whose forms are liable to almost infinite variations. We think our specimen is pretty certainly *E. semilunata*, but possibly that, and the other, non-callous shell, *E. transversa*, given by Lamarck, may be merely varieties in shape of the same species.

† *Having one muscle.*

This order consists of three sections, the first containing three families, the second and third, two each.

Section 1st.

Ligament marginal, elongated on the edge, sublinear.

Most of the shells of this section adhere to marine substances by a byssus; several of them are equivalve, not foliated.

1st Family.

TRIDACNEA, (2 genera.)

Shell transverse, equivalve, muscular impression below the middle of the superior margin, and extending, on each side, under it.

The shells of this family are regular, solid, and remarkable by their sinuous or wavy superior margins.

1. Tridacna *.

Shell regular, equivalve, inequilateral, transverse; lunula gaping. Hinge with two compressed, unequal, anterior, entering teeth. Ligament marginal, external.

Linnæus confounded the tridacnæ with the chamæ. They are rather handsome shells, often above the middle size, and sometimes so gigantic, that one species, (T. gigas,) is the largest shell known.

The animal has but one transverse muscle, and the interior of the shell exhibits a single, elongated, arched, muscular impression, running below the superior limb, and widest at the middle of the margin of the valves.

The tridacna is perfectly distinguished from the hippopus, by the lunula always being open and gaping, through which the animal protrudes a byssus, to fix its shell to the rocks, and by

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* From τρεις, *three*, and δακνω, *to bite.* A name given to a kind of oyster, so large as to require to be eaten in three pieces.—Plin. 32. 6.

which it is suspended, however large and heavy it may be. The cardinal teeth are on the anterior side, below the corselet. In most species, the margin of the lunular aperture is crenate.

Type. *Tridacna gigas* *. (Chama gigas? *Linn.*)

Shell very large, transversely ovate; ribs large, imbricate-squamose; squamæ short, arched, crowded; interstices between the ribs not striated.

Indian Ocean, 7 Species. Pl. I. Fig. 76.

A shell of this species was given to Francis I. of France, by the Republic of Venice, the valves of which are used to hold the holy water, in the Church of Saint Sulpice, at Paris. Although enormously large, there are others still larger. The biggest known is said to weigh five hundred pounds.

2. Hippopus †.

Shell equivalve, regular, inequilateral, transverse; lunula close. Hinge with two compressed, unequal, anterior, entering teeth. Ligament marginal, external.

The hippopus differs from the Tridacna, by having the lunula shut; the margin of the valves at that part being indented, but close together; wherefore the animal cannot fix itself to rocks by a byssus, like the tridacna, and consequently must have a different organization from that of the preceding genus.

The general form and appearance of the two shells is very similar.

One species. *Hippopus maculatus* ‡, (Chama hippopus. *Linn.*)

Shell transversely ovate, ventricose, ribbed, subsquamose, white with purple spots; lunula cordate, oblique.

Indian Ocean. Pl. I. Fig. 77.

2nd. Family.

MYTILACEA, (3 Genera.)

Cardinal ligament subinternal, marginal, linear, very entire, occupying a large portion of the anterior margin, and, by its elasticity, tending to keep the valves open.

The shell of the mytilacea is elongated, equivalve, regular, seldom foliated with a slight, usually rather elongated muscular impression on each valve. The contraction of the muscle of attachment enables the animal to close the shell completely, (except those which have gaping valves,) but as that, if continual, might be injurious to it, it is provided with an interior, and sometimes double adductor, ligament, first noticed by Dr. Leach, which keeps the valves half open for the free passage of the water, at once counteracting the tendency of the cardinal ligament to open the shell entirely, and relieving the muscle from a state of constant contraction. Most of these shell-fish are fixed to marine bodies by a byssus, and have a tongue shaped, or conical foot, which they use to draw out and attach the filaments of the byssus.

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* *Giant.* † From ἱππος a *horse*, and πους a *foot*. ‡ *Spotted*.

1. Modiola*.

Shell-subtransverse, equivalve, regular; posterior side very short. Beaks almost lateral, depressed on the short side. Hinge without teeth, lateral, linear. Ligament cardinal, almost wholly internal, inserted in a marginal channel, beginning under the beaks, and extending to part of the anterior, inferior margin of the valves. One sublateral, muscular impression, elongated, axe-shaped.

Almost all naturalists have hitherto confounded the modiolæ with the mytili. They differ from them however, in being rather transverse than longitudinal shells, the beaks not being truly terminal, a slight projection of the posterior side extending beyond them; which projection Lamarck considers as the short side of the shell. Moreover they are rarely fixed by a byssus, although they are spinners, (*fileuses,*) like the mytili. Their muscular impression is superficial, and analogous to that of the mytili. They usually gape a little at the middle of the contracted margin of the posterior side.

Type. *Modiola papuana* †.

Shell oblong, solid, whitish violet; anterior side obliquely dilated; umbones tumid, obtusely angular.

North America. 23 recent Species, 5 fossil. Pl. I. Fig. 78.

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* A little measure, or bucket: diminutive, from *modius*, a *bushel.* † *Papuan.*

2. Mytilus *.

Shell longitudinal, equivalve, regular, pointed at the base, fixed by a byssus. Beaks almost straight, terminal, pointed. Hinge lateral, usually without teeth. Ligament marginal, subinternal. One elongated, clavate, sublateral muscular impression.

Linnæus confounded the ostreæ, aviculæ, anodontæ, &c., with mytili, though the two first, are inequivalve and foliated, and the last, fresh-water shells.

The mytili are all sea shells, not foliated, nor gaping at the superior margin, in which they differ from the pinna, which in other respects they a good deal resemble. Their byssus is short, with thick or coarse filaments, which they attach and detach by means of a linguiform foot. They have a rather slender adductor ligament in the upper internal part of the shell, answering the same purpose as that of the modiola; and another ligament, pretty much like the former, in the base of the shell, near the beaks, to strengthen the connexion of the valves at the hinge.

The species are subdivided into, (1) Shells longitudinally furrowed,—11 species,—and (2) Those having no longitudinal furrows, 24 Species.

Type. *Mytilus Magellanicus* †.

Shell oblong, angular and whitish below; purplish violet above, with thick, wavy longitudinal furrows; nates acute, nearly straight. *Streights of Magellan.* In all 35 recent species, and 2 fossil. Pl. I . Fig 79.

3. Pinna ‡.

Shell longitudinal, cuneiform, equivalve, gaping at the summit, base pointed, beaks straight. Hinge lateral, without teeth. Ligament marginal, linear, very long, almost internal.

The pinnæ are sea shells, generally very large, thin in proportion to their size, often brittle; upper margin rounded sometimes almost truncated. Ligament narrow, and so compact, that the valves seem to be joined together on the hinge side, and admit of little motion for opening them. Texture of the shell, though thin and sometimes foliated, solid; its fracture exhibits delicate transverse striæ, similar to those of gypsum.

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* Original Latin name for the muscle shell fish.

† From the Straits of *Magellan.*

‡ Πιννα, *pinna*, a kind of shell fish, also a *plume*, whence the name.

The pinnæ are distinguished from the mytili, by the straightness of the beaks, and the gaping of the superior extremity.

The animal is long, without any projecting siphon, and has a conical linguiform foot, which it uses in fixing its fine, long, shining, and silky byssus.

Type. *Pinna rudis* * (Idem, *Linn.)*

Shell large, oblong, ferruginous red; apex obliquely rounded; furrows thick, squamiferous; squamæ large, semi-tubular.

Atlantic Ocean. 16 Species. Pl. I. Fig. 80.

3rd Family.

MALLEACEA. (5 Genera.)

Ligament marginal, sublinear, either interrupted by indentations, or serial teeth, or quite simple. Shell sub-inequivalve, foliated.

Although allied to the mytilacea by similarity of position of the ligament, the mallacea differ from them by the foliated texture of the shell, and by its being irregular and inequivalve. Their ligament also is not perfectly internal, for, extending along the lower margin of the valves, the facets which receive it incline outwards, forming an open channel, and discovering more or less of the ligament.

1. Crenatula †.

Shell subequivalve, flattened, foliated, rather irregular. No particular aperture or pit for the byssus. Hinge lateral, marginal, linear, indented; indentations serial, callous, hollowed into pits, and receiving the ligament.

The hinge of the crenatula a good deal resembles that of the perna, but it is singular, by presenting a row of callous and rather concave indentations, which receive the ligament, whereas that of the perna has a row of linear, parallel, truncated teeth, articulating with those of the opposite valve, the ligament being inserted in the interstices of the corresponding teeth.

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* *Rude.* † *A little notch,*—dim. from *crena,* the *notch of an arrow,* &c.

The crenatulæ are rare shells, generally thin, sometimes almost membranous, and brittle.

Type. *Cranatula modiolaris*[*].

Shell sub-cuneiform, compressed, sub-membranaceous, reddish, radiated with white; nates below the base, separated by a sinus. *South American Seas.* 7 Species. Pl. I. Fig. 81.

2. Perna[†].

Shell subequivalve, flattened, rather deformed; texture lamellar. Hinge linear, marginal, composed of sulciform, transverse, parallel non-entering teeth, between which the ligament is inserted. A posterior sinus, slightly gaping, below the extremity of the hinge, for the passage of the byssus; sides callous.

The hinge of the perna is so peculiar, that it is surprising Linnæus should have classed it with the ostreæ; it does not even belong to the family of ostracea. It differs from the arca, by the cardinal teeth of one valve not articulating with those of the opposite valve, but, when the shell is shut, lying upon them. The ligament also is differently situated from that of the arca. They have much more resemblance to the crenatulæ; they are sea shells, with small, nearly equal beaks, situated at one of the extremities of the hinge. The shell, though pretty solid, is composed of ill-joined laminæ, as is the case, with the other malleacea.

Type. *Perna ephippium*[‡]. (Ostrea ephippium. *Linn.*)

Shell compressed, on the upper part orbicular; posterior side longest; margin very acute. *Indian Ocean.* 10 recent species, and 2 fossil. Pl. I. Fig. 82.

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[*] Allied to *modiola*. Lamarck's second species. His type is *C. avicularis*.

[†] Perna, strictly, is a gammon of bacon, with the leg on. It was used to denote a kind of shell fish, (very probably our perna,) from its resemblance to a pig's foot. (Plin. 32. sub. fine.)

[‡] From *επι*, *upon*, and ἱππος, a *horse*—a *saddle*.

3. Malleus*.

Shell subequivalve, rude, deformed, generally elongated, sublobate at the base; beaks small, diverging. Hinge without teeth. An elongated, conical pit, below the beaks, obliquely traversing the facet of the ligament. Ligament subexternal, short, inserted in the short, sloping facet of each valve.

The mallei are distinguished from the pernæ by their hinge; from the aviculæ by the conical pit below the beaks, and by the valves being, though irregular, of the same size, and having no sinus on the left valve. The mallei are remarkable for their form; they are coarse, irregular shells, with little beauty externally. Internally they are rather brilliant pearly, especially at the part occupied by the body of the animal. They are exotic sea shells, and some of the species (as the malleus albus) very rare. They have a byssus, which protrudes through a small posterior aperture, near the beaks. The inclined sides of the valves form an open channel at the base.

Type. *Malleus albus* †.

Shell trilobate; lateral lobes of the base very long; no sinus for the byssus, or not distinct from the pit of the ligament.

South-oriental seas. 6 Species. Pl. I. Fig. 83.

4. Avicula ‡.

Shell inequivalve, brittle, rather smooth; base transverse, straight; extremities produced, the exterior caudate. A sinus in the left valve for the passage of the byssus. Hinge linear, unidentate; cardinal tooth of each valve under the beaks. Facet of the ligament, marginal, narrow, channelled, not traversed by the byssus.

When the valves are spread open, without separating, the shell has a rude resemblance to a bird on the wing, whence its name.

The aviculæ are sea shells, generally muticate, or not squamose externally, thin, and pearly within. Their beaks are oblique, small, and not prominent.

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* *A hammer.*

† *White.*

‡ *A little bird.*

Type. *Avicula crocea*[*].

Shell smooth, muddy yellow, not spotted; wing obliquely divaricate.

Isle of France. 15 Species. Pl. I. Fig. 84.

5. Meleagrina[†].

Shell equivalve, quadrato-rotundate, externally squamose; lower cardinal margin straight, anteriorly not caudate. A sinus at the posterior base of the valves, for the passage of the byssus; margin of the left valve at that part narrow, emarginate. Hinge linear, without teeth. Facet of the ligament marginal, elongated, subexternal, dilated in the middle.

The meleagrina is distinguished from the avicula, by the different form of its shell, which is nearly equivalve, by its never having the tail nor cardinal teeth of that genus, and by the widening of the ligamental facet at the middle part. The aperture for the byssus also occasions a callous, re-entering angle on each valve, which is not found on the aviculæ. The meleagrina is not so smooth, and more squamose than those shells; its internal pearly coat is sometimes thick, and very brilliant, and it often contains true pearls. The finest of those "costly and beautiful substances[‡]," are found in one species, (*M. margantifera*,) of this genus.

Type. *Meleagrina margaritifera*[§]. (Mytilus margaritiferus, *Linn.*)

Shell subquadrate, rounded above, greenish brown, with white rays; lamellæ longitudinal, imbricate; the upper ones largest.

Persian Gulf. 2 Species. Pl. II. Fig. 85.

Section 2nd.

Ligament not marginal, contracted into a short space below the beaks, always visible, and not forming a tendinous cord under the shell.

The shells of this section are well distinguished from those of the preceding by the form and situation of the ligament.

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[*] *Saffron colour—yellow.* Lamarck's sixth species.

[†] Μελεαγρις, a Guinea fowl.

[‡] Davy.

[§] *Pearl-bearing.*

They are generally auriculated at the base or extremity of the cardinal margin. They are all inequivalve, for, though in many the valves are of the same size, one of them is always more convex than the other.

1st. Family.

Pectinida. (7 Genera.)

Ligament internal, or semi-internal. Shell generally regular, compact, not foliated.

The pectinida are usually auriculated, and striated; the striæ, or ribs, radiating from the beaks. The ligament is internal, but sometimes visible on the outside, in consequence of an indentation between the beaks, or of their distance from one another. Some are free shells, which the animal attaches at pleasure by a byssus; others are fixed to marine substances by the lower valve.

1. Pedum *.

Shell inequivalve, slightly auriculated, lower valve gaping. Beaks unequal, distant. Hinge without teeth; ligament partly external, inserted in an elongated, channel-shaped pit, formed in the lower side of the beaks; lower valve notched near the posterior base.

The pedum is a free, regular, inequivalve shell; and the singular notch of the lower valve shews that the animal has the power of attaching it by a byssus. One Species.

Type. *Pedum spondyloideum* †, (Ostrea spondyloidea. *Gmel.*) Shell cuneiform oval, rather flat; upper valve longitudinally striated; striæ rough, granular.

Indian Seas. Pl. II. Fig. 86.

2. Lima ‡.

Shell longitudinal, subequivalve, auriculated, slightly gaping at one side between the valves; beaks distant, their internal facet inclining outwards. Hinge without teeth. Cardinal pit partly external, receiving the ligament.

The lima has no notch on the lower valve; the little ears at the base of the shell, though small, are distinct. Linnæus aranged these shells with the ostreæ, but they differ from them in being free, regular and almost equivalve, and from the pectines by their remote beaks, and cardinal pit. They are sea-shells, and generally white.

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* *A shepherd's crook.* † *Resembling a spondylus.* ‡ *A file.*

Type. *Lima squamosa* *. (Ostrea Lima. *Linn.*)

Shell oval, depressed, cut off as it were at the fore part; ribs squamose, very rough; hinge oblique; margin plicate.

American Ocean. 6 recent species, and 5 fossil. Pl. II. Fig. 87.

3. Plagiostoma †.

Shell subequivalve, free, subauriculated; cardinal base transverse, straight. Beaks rather remote, their inner sides extending into transverse, flattened, external facets, one straight, the other obliquely inclined. Hinge without teeth. A conical cardinal pit, situated below the beaks, partly external, opening outwards and receiving the ligament.

The plagiostoma differs from the pecten, by the beaks not being contiguous, by the external and flattened facets of the cardinal base, and by the pit for the ligament opening, by a hole, outwards. Except that it wants their two cardinal teeth, the hinge of the plagiostoma resembles that of the spondylus. It is distinguished from the lima by not gaping at either side, whence it cannot be attached by a byssus; for it is a mistake to suppose that the external aperture of the ligamental pit serves for the passage of that apparatus, a circumstance which never occurs with the conchifera, and is incompatible with the disposition of the organs of the animal. The plagiostoma is only known in the fossil state; its shell is generally thin, even in those of large size. This genus was first observed by Mr. Sowerby.

Type. *Plagiostoma transversa* ‡.

Shell very large, transversely ovate, rounded above; lower sides oblique; longitudinal furrows very numerous, transversely striated. 6 Species. Pl. II. Fig. 88.

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* *Squamose.* Lamarck's second Species. His type is *L. inflata.*

† From Πλαγιος, *oblique*, and *στομα*, a *month.*

‡ *Transverse.*

4. Pecten *.

Shell free, regular inequivalve, auriculated; inferior margin transverse, straight; beaks contiguous, with no intermediate facet. Hinge without teeth: a triangular cardinal pit, wholly internal, receiving the ligament.

The pectines are almost always longitudinally radiated with fine or coarse ribs; the base of the shell is terminated by a straight, transverse line, beyond which the beaks never project. The valves are generally thin, of equal size, but not equally convex, the upper being almost constantly flattened; their texture is not loose-foliated like that of the ostreæ. They are sea-shells, much diversified, very numerous in species, and the species not easily determined; they are usually ornamented with various and brilliant colours. They are always auriculated, and the largest ear is on the posterior side, and beneath it is a sinus.

The species are subdivided into (1) Shells with the ears equal, or nearly equal,—26 species; and (2) Those with the ears unequal,—32 species.

Type. *Pecten maximus* †. (Ostrea maxima. *Linn.*)

Shell inequivalve, upper valve almost flat; radii rounded, longitudinally striated. *European Seas.* In all 59 recent species, and 26 fossil. Pl. ~~II~~. Fig. 89. III

5. Plicatula ‡.

Shell inequivalve, not auriculated, contracted towards the base; upper margin rounded, subplicate; beaks unequal, with no external facet. Two strong cardinal teeth on each valve, with an intermediate pit which receives the ligament; ligament wholly internal.

The plicatulæ are sea-shells; they differ from the pectines by having cardinal teeth, and being without ears; and from the spondyli, by having no external facet, nor consequently the intermediate furrow, occasioned by the ligament of the spondyli; nor are they spinous, like those shells.

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* *A comb.* Also the original Latin name for all shell-fish, striated, or ribbed like cockles.

† *The largest*

‡ Dim. from *plica*, a *fold*, or *wrinkle*.

Type. *Plicatula cristata* *.

Shell oblong, cuneiform, ferruginous, subcristate; folds large, simple, squamose.

American Seas. 11 Species. Pl. II. Fig. 90.

6. Spondylus †.

Shell inequivalve, adhering, auriculated, spinous or rough; beaks unequal; an external, flattened, cardinal facet on the lower valve, divided by a furrow. Two strong cardinal teeth on each valve, with an intermediate pit for the ligament, communicating at its base with the external furrow. Ligament internal; remains of former ligaments perceptible externally in the furrow.

The spondyli are particularly distinguished from the ostreæ by the cardinal teeth; they are generally covered with spines, which are occasionally very large, subulate, or lingular; sometimes simple, sometimes foliated at their summit, and always disposed in rows, or longitudinal, radiating striæ, or ribs. They are for the most part variously and brilliantly coloured; the lower valve is always the largest and most convex, and is terminated at the beak, by a kind of talus, which appears as if cut with a sharp instrument, and presents a flattened, inclined, triangular facet, divided by a furrow. This cardinal area increases in length by age, in consequence of the animal changing its place in the shell as it grows, and at the same time displacing the upper valve ‡.

The animal, like that of the pecten, has two rows of short, tentacular threads on the border of the mantle, and the vestige of a foot, in the form of a radiated disc, and furnished with a short pedicle.

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* *Crested.* Lamarck's third species. His type is *P. ramosa.*

† Σπονδυλος, *spondylus*, a *knuckle*, or *vertebra.* Also the original Latin name for a kind of shell-fish.

‡ On this supposed dislocation of the upper valve, Mr. Sowerby very pertinently remarks, "The teeth of the two valves are so formed, that without breaking away some portions of them, or of the circumjacent parts of the hinge, the two valves cannot be separated. We have mentioned this fact before in our account of the genus ostrea; and we here repeat it, to shew how impossible it is that the animal should displace its upper valve, as Lamarck asserts, in order to produce the progressive elongation of the area of the hinge of the lower valve." (Genera of Recent and Fossil Shells. No. 9.)

Type. *Spondylus gæderopus*. (Idem. *Linn.*)

Shell red above; striæ small, longitudinal, close together, rough, granular; from six to eight rows of sublingulate, truncated, middle-sized spines.

Mediterranean. 21 recent species, 4 fossil. Pl. 2. Fig. 91.

7. Podopsis.

Shell inequivalve, subregular, adhering by the lower beak, inauriculate; lower valve largest, most convex, and its beak most prominent. Hinge without teeth. Ligament internal.

The podopsides, which are only known in the fossil state, are similar in some respects to the gryphœa, but are distinguished from them, by the lower beak not being curved either above the upper valve, or over the side. They resemble the pectines by their regularity, by the shell not being foliated, and by their longitudinal striæ. They appear to have some relation to the plagiostoma, but differ from them in being fixed shells, and in wanting the opposite beaks, with their intermediate, obliquely inclined facet. The upper valve of the podopsis, which is always shorter than the other, seems to have no beak, in consequence of its not being curved or prominent.

Type. *Podopsis truncata* *.

Shell longitudinal, cuneiform, rounded above, suboblique; striæ longitudinal, thin, sometimes rough, with a few prickles; longest beak crenate.

Touraine. Pl. II. Fig. 92.

2nd Family.

OSTRACEA. (5 Genera.)

Ligament internal, or semi-internal. Shell irregular, texture foliated, sometimes papyraceous.

Almost all the ostracea are irregular shells, of a foliated or lamellar texture, seldom auriculated at the base, and still more rarely radiated externally.

The animal has no foot, arm, or projecting siphon; in many species, the shell is fixed to marine bodies by the lower valve, which is always the largest. The first three genera of this family have a semi-internal ligament, a foliated, and often very thick shell. The two last have the ligament internal, and the shell thin or papyraceous.

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* *Truncated.*

1. Gryphœa [*].

Shell free, inequivalve; lower valve large, concave; beak prominent, curved spirally inwards; upper valve small, flat, opercular. Hinge without teeth; cardinal pit oblong, arched. A single muscular impression on each valve.

Animal unknown.

The generally large curved beak of the lower valve of the gryphœa, usually projects considerably, either above the upper valve, or laterally, which eminently distinguishes these shells from the ostreæ; they are, besides, almost always free shells, or if they adhere at all to other bodies, it is only by a point; most of them appear to be regular shells. The lower valve is always much larger than the upper. They are all, but one species, fossil, and are probably sea-shells.

Type. *Gryphœa angulata* [†].

Shell oblong ovate; three longitudinal ribs underneath, angular-carinate; beak large, suboblique. Recent. Locality not given.

11 Fossil species. Pl. II. Fig. 93 [‡].

2. Ostrea [§].

Shell adhering, inequivalve, irregular, beaks distant, becoming very unequal by age; upper valve smallest, generally flat, and gradually advancing forward, during the life of the animal. (See note *, p. 41.) Hinge without teeth. Ligament semi-internal, inserted in the cardinal pit of the valves; pit of the lower valve increasing by age, sometimes to a great length.

Linnæus, looking only to their mutually being without teeth, associated the beautiful genus of the pectines, with that of the ostreæ, notwithstanding the former are free, regular shells, and have the ligamental pit wholly internal. He, moreover, referred some true ostreæ to his mytili, viz., *mytilus crista galli*, *mytilus hyotis*, and *mytilus frons;* and added the whole genus perna, to the ostreæ, although their hinge is so peculiar by its characteristic indented line. Bruguiere first established the principal limits of this genus, and Lamarck has since further reduced them, by separating the vulsella, podopsis, and gryphœa.

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[*] From γρυπος, one that has a *hooked nose.*

[†] *Angular.*

[‡] We have given a second figure of this genus, viz., G. *Cymbium*, (fossil, fig. 93 *,) the G. *angulata*, being very rare and less characteristic of the species usually found in the blue lias, &c.

[‖] *Oyster.*

The shell of the ostrea is rude, rugged, often squamose, sometimes singularly plicated at the margins, and frequently very thick. It does not curve upwards, like that of the gryphœa. The texture of the valves is loose-foliated; the lower one, which is the largest, and by which it adheres to marine bodies, is more convex than the upper.

The species are subdivided into (1) shells, with simple, or wavy margins, but not plicate—32 species; and (2) those with distinctly plicated margins—16 species.

Type. *Ostrea edulis* *. (Idem. *Linn.*)

Shell ovate-rounded, base sub-attenuated; membranes imbricate, wavy; upper valve flat. *European seas.* In all 48 recent species, and 33 fossil. Pl. II. Fig. 94.

8. Vulsella †.

Shell longitudinal, subequivalve, irregular, free; beaks equal. Hinge with a prominent callus on each valve, depressed above, with the impression of a conical, obliquely arched pit, for the ligament.

The vulsellæ, though nearly allied to the ostreæ, are distinguished from them, by having the valves always of nearly equal size; the beaks equal, though somewhat separate; an equal, projecting callus in the interior of each valve, under the beaks; and by the shell never being fixed by its lower valve. They are often found in sponges; are pearly internally, and some species gape a little at the posterior side.

Type. *Vulsella spongiarum* ‡.

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* *Eatable.*

† Or volsella—*tweezers.*

‡ *Of spunges.* Lamarck's 4th species. His type is *V. lingulata.*

Shell oblong, straight; base attenuated; internally purplish white; transverse concentric wrinkles; longitudinally obsolete.

Indian Ocean. 7 Species. Pl. II. Fig. 95.

4. Placuna [*].

Shell free, irregular, flattened, subequivalve. Hinge internal, with, on the upper valve, two sharp longitudinal ribs, close at the base, and diverging in the form of the letter V; on the other, two ligamental impressions, corresponding to the cardinal ribs.

The two oblong, prominent, rib-like laminæ, in the form of a V, situated at the internal hinge, on the upper valve of the shell, is the essential character of this genus; they serve for the attachment of the ligament, inserted in the two impressions of the same form observable in the opposite valve. The valves of the placunæ are thin, transparent, and of the same size. These shells are large, orbicular, or subtriangular, sometimes triangular, with only one internal muscular impression, like the ostreæ. Their texture is foliated.

Type. *Placuna sella* [†]. (Anomia sella. *Linn.*)

Shell subquadrangular, curved, broad, irregularly sinuous, lamellar, wavy; bronze-coloured; striæ longitudinal, very fine.

Indian Ocean. 4 Species. Pl. II. Fig. 96.

5. Anomia [‡].

Shell inequivalve, irregular, operculated, adhering by the operculum; smaller valve perforated, usually flat, having a hole or notch at the beak; the other valve rather larger, concave, entire. Operculum small, elliptical, osseous, connected with the internal muscle of the animal, and fixed to marine bodies.

The operculum of the anomia has been absurdly mistaken for a third valve, being, in reality, only the dilated and thickened extremity of the tendon of the interior muscle of the animal, which forms a small, solid, elliptical, and almost bony mass, of such a shape as to fill the hole or notch of the beak of the flat valve, when the muscle is contracted. The perforated flat valve is usually considered as the lower one in this genus, as being that which rests on the bodies to which the shell is attached; whilst with the ostreæ, the larger and most concave is correctly styled the lower valve. The contrary is the case with the terebratulæ, because it is the largest and most concave valve of that shell which is perforated at the beak. Independently of the muscular attachment of the animal to the operculum, the two valves are connected by an internal, cardinal ligament, the impression of which is very perceptible.

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[*] From πλαξ, a *broad table*?

[†] *A saddle.*

[‡] Ανομια, from α, *not*, and νομος *law*,—*non-conformity to the usual order, anomalous.*

The organization of the animal, according to Poli, is similar to that of the oyster.

Type. *Anomia ephippium* *. (Idem, *Linn.*)

Shell suborbicular, rugose-plicate, wavy, rather flat; foramen oval.

Mediterranean. La Mancha, &c. 9 Species. Pl. II. Fig. 97.

Section 3rd.

Ligament either none, or unknown; or represented by a tendinous cord which supports the shell.

The shells of the two preceding sections have true, known ligaments; those of the one we are now entering on have in reality no true ligament, for the tendinous cord observed in some of them, is merely the extremity of the muscle of attachment of the animal, which passes through a hole, in the large beak of the shell, and fixes itself to foreign substances, but by no means serves to support the valves. This section contains two families.

1st. Family.

RUDISTA. (6 Genera.)

Ligament, hinge, and animal unknown. Shell very inequivalve. No distinct beaks.

The two remaining families, the last of the conchifera, present us with very singular shell-fish, sometimes in consequence of the form of the shell, and sometimes from the peculiarities of the animal, of which we find no example in the other conchifera.

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* *Saddle.*

The rudista are allied to the ostracea in certain respects, but are eminently distinguished from them, by having neither hinge, valvular ligament, nor muscle of attachment, nor any indication of the places where these objects should be found. As they are all fossil-shells, we can form no idea of the characters of the animal that once inhabited them.

1. Sphœrulites *.

Shell inequivalve, orbiculo-globular, somewhat depressed above, externally echinate with large, subangular, horizontal scales. Upper valve smallest, rather flat, opercular: its internal surface furnished with two unequal, subconical, curved, and projecting tuberosities; lower valve larger, rather ventricose, with radiating scales, extending beyond the margin; cavity obliquely conical, forming on one side, by the folding of the internal margin, a crest, or projecting keel. Interior of the cavity transversely striated. Hinge unknown.

The sphœrulites differ from the radiolites by having large subangular scales on their exterior surface, which gives them a foliated appearance, and by some dissimilarity in point of form, their upper valve being rather flattened, instead of conical; and it seems doubtful, if the interior surface of the smaller valve of the radiolites have the two tuberosities of the sphœrulites; or if the crest, or projecting keel, formed by the folding of the internal margin, on one side of the cavity, can be found in its greater valve.

One Species. *Sphœrulites foliacea* †.

No further description. *Isle of Aix*. Pl. II. Fig. 98.

2. Radiolites ‡.

Shell inequivalve, externally striated; striæ longitudinal, radiating. Lower valve turbinated, largest; upper valve convex, or conical, cpercular. Hinge unknown.

The radiolites appear to be formed of two, often very unequal cones, applied base to base, and externally striated, but are not squamose. These fossils are only found in the older formations; they are tolerably abundant in the Pyrenees.

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* From *sphærula*, a *little globe*. † *Foliaceous*. ‡ From *radius*, a *ray*.

Type. *Radiolites rotulans* *.

Valves of the shell conical, applied base to base, rather short, subequal. *Pyrenees.* Pl. II. Fig. 99.

3. Calceola †.

Shell inequivalve, triangular, turbinated, flattened below. Largest valve hood-shaped, obliquely truncated at the aperture; cardinal margin straight, transverse, slightly notched, and indented in the middle; superior margin arched. Smaller valve flattened, semi-orbicular, opercular, with a tubercle on each side of the cardinal margin, and in the middle a pit with a small lamina.

The calceola is a thick, solid shell, and in form not unlike a half-sandal. Its cavity is striated from the centre to the circumference. The upper (flat) valve is marked externally with concentric striæ; its cardinal margin seems to articulate with the turbinated valve by a straight, linear, transverse hinge. In some individuals, the upper valve is slightly convex. Its lateral tubercles have three grooves.

One species. *Calceola sandalina.* ‡. (Anomia sandalium, *Linn.*) No further description. *Environs of Juliers.* Pl. II. Fig. 100.

4. Birostrites §.

Shell inequivalve, bicornute; valves, in consequence of the elevation of the disc, conical, unequal, obliquely diverging, nearly straight, hornshaped; the base of one valve enveloping that of the other.

The birostrites is composed of two pieces, or valves, not united by the margins of their bases, but one valve enveloping the other, and the dorsal disc of each elevated into an almost straight cone, slightly arched within. These hornshaped valves, are unequal, and diverge obliquely in the form of a very open V. One valve appears to spring from the base of the other, the shorter being always the enveloped valve. The interior of the shell is unknown.

One species. *Birostrites inequiloba* ‖.

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* From *rotula*, a *little wheel*.

† *Calceolus, a little shoe.*

‡ From *sandalum*, a sandal.

§ From *bis, twice*, or *double*, and *rostrum*, a *beak*.

‖ *Unequally lobed.*

Shell with two conical, elongated, beak-shaped, unequal valves, disposed at a very open angle, and united at their base; margin of one valve enveloping that of the other valve.

Locality unknown. Pl. II. Fig. 101.

Lamarck observes, in addition to what we have already quoted, that the genus Birostrites is certainly very different from his Diceras. Mr. Sowerby having had the opportunity of examining a *cast* of the *inside* of a birostrites, is convinced "that it ought to be placed next to diceras, or at least in the same family with chama and diceras, (inasmuch as it accords very nearly with those shells in its internal characters,) and that it should not be placed in his (Lamarck's) family of rudistes." Mr. Sowerby is further of opinion, that "the whole family of *rudistes* might be struck out;" for two of the six genera which it contains, *sphærulites* and *radiolites*, he thinks are not shells; that *calceola* probably belongs to the next family, *brachiopoda;* that *discina* should be expunged, as being identical with *orbicula;* and that "*crania* is decidedly a brachiopode." We very much incline to Mr. Sowerby's opinion; but as our professed object is to give the *Genera of Lamarck*, we do not feel ourselves at liberty to make the alteration he suggests to its full extent: he has, however, so satisfactorily proved the identity of *discina* and *orbicula*, that we do not hesitate so far to act on it, as to omit the former altogether. For Mr. Sowerby's arguments we refer our readers to his paper, in the 13th vol. of the *Transactions of the Linnean Society.*

5. Crania*.

Shell inequivalve, suborbicular; lower valve almost flat, perforated at the interior surface by three unequal oblique holes; upper valve very convex, having two internal prominent calli. Animal unknown.

The crania generally adheres by its lower valve, the three holes in which do not seem to perforate it completely, unless by accident, when removed from the body to which it was fixed by the outer surface; hence they cannot be the issues of muscular attachments.

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* *Cranium*, a skull.

These holes give the lower valve the appearance of a death's head*.

Type. *Crania personata* †. (Anomia craniolaris, *Linn.*)

Shell orbicular; the more gibbous valve conico-convex; the flatter, with three little pitsat the base.

Indian Seas. The only recent species known—the other four species are fossil. Pl. II. Fig. 102.

2d Family.

BRACHIOPODA ‡, (3 genera.)

Conchifera with two opposite, elongated, fringed arms, near the mouth, which are rolled up in a spiral form, and enclosed in the shell, when in a state of rest. These are peculiar to the brachiopoda. Mantle with two lobes, separated in front, enveloping or covering the body.

Shell bivalve, adhering to marine bodies, either directly, or by a tendinous cord.

The shell of the brachiopoda is more or less inequivalve, and opens by a hinge. The true ligament of the valves is not known; the tendinous cord is merely a prolongation of the muscular attachment of the animal, and does not assist in opening the valves. The shell always adheres to marine bodies. This is the last family of the conchifera.

1. Orbicula§.

Shell suborbicular, inequivalve; no apparent hinge. Lower valve very thin, nearly flat, adhering to marine substances; upper valve subconical; summit more or less elevated.

The lower valve of the orbicula is sometimes so thin as to be

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[*] Mr. Sowerby finds that these holes are muscular impressions, and that they are four in number, instead of three, though two of them are so near together, that he is not surprised that Lamarck, on a slight examination, "should have described the genus *Crania* as having, in the lower valve, three oblique perforations." He suggests the following as an amended generic character of this shell. "*Crania.*—Bivalve, inequivalve, nearly orbicular, compressed, fixed; upper valve patelliform, with four internal muscular impressions; lower valve adhering, nearly flat, with four corresponding muscular impressions, two near the centre, approximating and nearly united, and two near the posterior margin, distant. No hinge.—*Trans. Linn., Soc.* xiii. Mr. Sowerby discovered the two fringed arms, peculiar to the brachiopeda, in a *Crania* from Shetland. It should therefore, as he observes, evidently be transferred to that family.

[†] *Masked.*

[‡] From βραχιων, an arm, and ϖους, a foot.

[§] *Crbiculus*, a little round ball.

scarcely perceptible, whence Muller supposed it to be an univalve shell, and referred it to the patellæ.

One Species. *Orbicula Norvegica* *. (Patella anomala. *Mull.*) Upper valve compressed, conical; summit pointed, inclining on one side towards the margin. *North Sea.* Pl. II. Fig. 103.

2. Terebratula †.

Shell inequivalve, regular, subtriangular, attached to marine substances by a short tendinous pedicle. Beak of the larger valve prominent, often curved, perforated at the summit by a round hole, or a notch. Hinge with two teeth; two almost osseous, slender, elevated, forked, and variously ramified branches, spring from the interior disk of the smaller valve, and serve as a support for the animal.

The terebratulæ appear to be sea-shells, of which some recent species are known, but the greater number are fossil. The hole in the beak of the largest valve serves for the insertion of the fleshy tendinous pedicle, by which the shell is fixed to marine substances. The hinge is formed of two teeth, belonging to the large valve, which fit into the pits of the lesser.

The animal of the terebratula is nearly allied to that of the lingula; like it, it has two opposite, elongated arms, fringed, or ciliated on one side, which it protrudes at pleasure beyond the shell; when it returns them, they form a double fold from bottom to top, their extremity only being curved, or rolled in a spiral form.

The species are divided into recent and fossil, and the former subdivided into (1) shells smooth, without longitudinal striæ, or furrows, 5 species, and (2) those longitudinally furrowed, 7 species. The fossil species are also similarly subdivided.

Type. *Terebratula vitrea* ‡. (Anomia vitrea. *Gmel.*) Shell ovate, ventricose, glassy, very thin, smooth; larger beak prominent: perforation small. *Mediterranean.* In all 12 recent species, and 47 fossil. Pl. II. Fig. 104.

3. Lingula §.

Shell subequivalve, flattened, oblong-oval, truncated at the summit, slightly pointed at the base; elevated on a fleshy tendinous pedicle, fixed to marine substances. Hinge without teeth.

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* *Norwegian.*

† *Terebratus, pierced*, in allusion to the perforation of the larger valve.

‡ *Glassy.*

§ *A little tongue.*

The animal of the lingula has two arms, and, according to Cuvier, two hearts. Its two arms are opposite, very long, fleshy, not articulated, fringed on one side through their whole length, extensible beyond the shell, and rolled up in a spiral form when drawn in.

Only one species. *Lingula anatina**. (Patella unguis. *Linn.*) Shell greenish, resembling in form a duck's bill. Pedicle cylindrical, from two to four inches long.

Molucca Seas. Pl. II. Fig. 105.

NOTE.—We are indebted to our accurate friend Mr. G. B. Sowerby, for pointing out a mistake which Lamarck has fallen into, in asserting all the shells of the family *Arcacea* to be marine. (See our last Number, p. 317.) *Nucula rostrata*, belonging to the 4th genus of the *Arcacea*, (*Arca rostrata*, *Gmel.*) is called by Schröter, *Area fluviatilis*, and he says that "*it is found in the rivers of the Coromandel coast.*" (See Schröter's *Naturgeschiste der Fluss Conchylien*, 1779.) Mr. Sowerby adds, that he believes there are several other *river arks*, but none of them are described by Lamarck, unless *A. senilis* be, as he suspects, a river-shell.

ART. VI. *On a Mode of protecting the Specula of Reflecting Telescopes.*

[In a Letter to the Editor from Dr. Ure.]

MY DEAR SIR,

I HAVE at present in my possession an excellent seven feet reflecting telescope, of nine inches aperture, mounted on the plan of the late Sir William Herschel's, but furnished with a curious mechanism for covering up the mirror very closely, or uncovering it, without opening the tube at the lower end, as is necessary in using Sir William's. By this means, it is completely protected from suffering by moisture in dewy nights, an accident which we cannot avoid, by carrying the instrument into an apartment before covering the mirror; for its relative coldness generally causes an immediate deposition of vapour on its surface in such circumstances. The mirror of the ten feet Herschelian belonging to the Glasgow Observatory, was injured one evening in this way. The following letter and

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† Adj. from *anas*, a *duck*.

drawing, by the constructors of the instrument, will explain more fully the above-mentioned mechanism.

I am, my dear Sir, yours truly,

ANDREW URE.

SIR, *Glasgow, 4th March,* 1823.

According to your request, we send you a description of the mode of mounting the large speculum of our telescope.

In one of the Gregorian construction of six inches aperture, we mounted the speculum on the Herschelian plan, but found from experience with it at the Glasgow Observatory, as well as with those made by that admirable astronomer, Sir William Herschel, that this mode was liable to many objections, being apt to suffer from dust falling from one's clothes, or drops of water from the cover in a dewy night; and its being easily touched by the finger of those, who were not aware of the mischief which may result to the delicate polish of a speculum from a moist hand. For the information of such persons as have not examined Sir William Herschel's telescopes, it may be necessary to state, that a portion of the three upper staves of the octagon-tube is cut through above the speculum, and hinged in one piece to form a moveable door, of sufficient size to admit of the speculum cover being readily applied or removed.

To get rid of the above-mentioned inconveniences, we fitted the speculum into a brass ring, furnished with a channel in front to receive the edge of the cover; the speculum itself being introduced from behind, and its back fixed in the usual manner. The lid or cover is formed of three pieces of brass, neatly fitted and hinged together. They are of such a size, that when lying down on the sides of the tube, the central segment of the three applies accurately to the inferior stave of the octagon, and the other two pieces rest inclined on the two staves to the right and left hand of the bottom one. In this position, it can intercept none of the light moving in the telescopic cylinder.

In the same line with the centre of the hinge, a square rod of iron is attached to the middle segment of the cover, projecting tangentially from it. On this a key is fitted to the inner surface of the folding lid, to which two slender springs are affixed. When the telescope is placed at an elevated angle, these springs prevent the lateral segments of the cover from falling forwards, or striking against the face of the mirror. These springs are not, however, so stiff as to hinder the cover from folding down to the wooden surface of the tube by its weight. At the top of the box, there is a spring catch (detent) fixed, to prevent the lid from falling off. The speculum box (frame) is attached to the end of the wooden tube, by resting in a step at the bottom; and having two screws to adjust its inclination to the axis, in the same way as adopted by Sir William Herschel. When in its place, the prismatic iron rod stands opposite to a hole in the tube, by which the key is introduced to open or cover up the mirror. A small sliding plate shuts up this hole.

Fig. 1, represents the speculum uncovered, with the lid lying against the under surface of the tube. The dotted lines are a section of the tube. A the speculum, B the box, C the lid, D the spring catch to hold the lid in its place. E the square rod, for the key to open it by. Fig. 2, shews the speculum box shut up, and fixed in the end of the wooden octagon by the adjusting screws, as at F.

We are, Sir, your obedient servants,

To Dr. Ure. (Signed,) John and Robert Hart.

Fig. I.

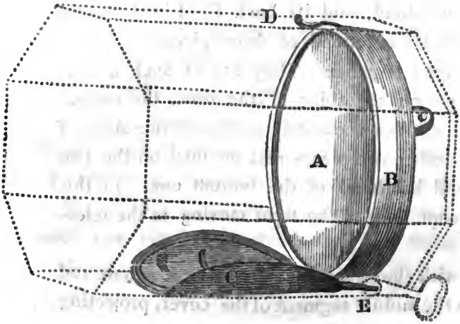
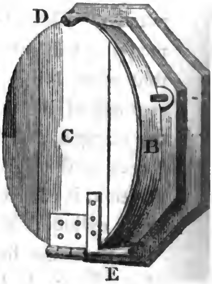


Fig. II.



ART. VII. *Experimental Inquiries relative to the Formation of Mists.* *By* GEORGE HARVEY, Esq., Member of the Astronomical Society of London.

MANY of the results contained in the following paper were obtained in consequence of repeating the interesting experiments on the temperature of air and water, performed by the President of the Royal Society, during his continental tour, and which he instituted with the view of tracing the causes which contribute to the formation of mists over the beds of rivers and lakes, in calm weather during the night, and an account of which may be seen in the *Philosophical Transactions* for 1819.

It must not be understood, however, that this essay is submitted to the readers of the *Journal of Science*, with the slightest idea that it can in any degree add to the unquestionable accuracy of the principles on which Sir Humphrey Davy has founded his theory; and it is, therefore, hoped that it will merely be regarded as a series of illustrative examples, which the local facilities of Plymouth and its neighbourhood have afforded for observations of this kind. These facilities arise from the *elevation* of the land surrounding the water, and from the *depth* of the river Tamer and of the sea; both of which, according to a remark of the above philosopher, are essential conditions, in order to produce a mist of any considerable density or magnitude. The present year afforded many opportunities for attending to this interesting subject, and in no case have I perceived any phenomena at all at variance with the principles laid down in the paper before quoted.

As this paper, therefore, will contain little more than a register of facts, they will be detailed nearly in the order in which they occurred, with the addition only of such observations as may have a tendency to illustrate the phenomena with which they are connected.

Some experimental inquiries, relating to the deposition of dew, rendered it necessary that the whole of the night of the 27th of April should be devoted to observations connected with the temperature of the atmosphere, and that of the grass of a meadow in which the experiments were performed. To leave no branch of the subject under consideration unexplained, thermometers of a very delicate construction, and placed in different situations, were successively examined every half hour, from half-past nine in the evening, to nine the next morning. From the hour first mentioned to four the succeeding morning, the temperature of the air, at an elevation of seven feet above the ground, *exceeded* the temperature of the surface of the meadow, and the upper sky and the horizon were lucid and clear. After four, however, an alteration in the aspect of the heavens, and also in the states of the thermometers, was perceptible; and at half-past four the air indicated 39½° F., and the ground 40¼° F.; whereas, at four, the former was 41° F., and the latter 40° F. At this moment a thin haze was visible by the aid of the twilight, hovering over the marshy lands at the foot of the meadow, and at five had considerably increased, both in density and quantity, the temperature of the air at this moment being 40° F., and the ground 41½° F. At halfpast five A.M., the mist had very much increased, extending itself into some of the adjacent fields, and having its density perceptibly greater. A reference to the thermometer also indicated a still greater difference between the temperature of the air and ground than in the former instances, the air still retaining its temperature of 40°, but the temperature of the ground had increased to 43½°. At six A.M., the mist had so much increased as to obscure the neighbouring town of Stonehouse, and which had been visible during the former part of the night. The temperature of the air at six was 41½°, and the ground 46½°; and from this hour until nine A.M., the time when the last observation was made, the ground still continued to possess a temperature *greater* by several degrees than the air, and during the whole time of observation the mist continued of considerable density.

From the preceding observations it appears, that the quantity and density of the mist increased in proportion to the *excess* of the temperature of the ground *above* that of the air. One of the conditions mentioned by Sir Humphry for the formation of mist in great quantity over water is, that the *excess* of its temperature *above* that of air should be as great as possible.

The temperatures of the air and of the ground, at the moment when the mist was first perceived, were not, however, the maximum depressions for the night, for at 3 A.M. the air indicated 39°, and the surface of the meadow 38°. These greatest depressions of temperature were perceived just at the moment when the first golden streak of the dawn had appeared, and when the particles of dew which had been deposited on the upper surface of a plate of glass, elevated six inches above the ground, were completely frozen, the moisture on its under side remaining in a fluid state. As the entire series of observations may be acceptable, they are here given.

Time.	Temperature of the Ground.	Temperature of the Air, 7 Feet above the Ground.	Time.	Temperature of the Ground.	Temperature of the Air, 7 Feet above the Ground.
h.	°		h	°	°
9½ P.M.	45½	48½	3½ A.M.	38½	40
10 P.M.	41½	45	4 A.M.	40	41
10½ P.M.	43½	46	4½ A.M.	40¼	39½
11 P.M.	41	43½	5 A.M.	41½	40
11½ P.M.	39½	44½	5½ A.M.	43½	40
12 P.M.	39	43	6 A.M.	46½	41½
½ A.M.	39	40	6½ A.M.	48	44
1 A.M.	41½	42	7 A.M.	52½	49
1½ A.M.	40	42	7½ A.M.	53½	51½
2 A.M.	40	42	8 A.M.	53½	50
2½ A.M.	39¾	40	8½ A.M.	57½	53
3 A.M.	38	39	9 A.M.	62	57

The night of the 15th of May was dedicated to similar pursuits. Observations were made from sun-set to sun-rise, every quarter of an hour, and in no case was the temperature of the air found *below* that of the ground, the nearest approach to a state of equality having been at 5 A.M., when the warmth of the air exceeded that of the ground 2¼°. No mist, however, was formed during the night on any of the neighbouring sheets of water, or on the marshy lands below the meadow. The greatest depression of temperature took place at four, about twenty minutes before sun-rise, which same hour indicated also the least temperature of the glass, of a thermometer laying on the ground, and covered by a glass plate, which rested on its bulb; also of a thermometer placed on the upper surface of the glass, and likewise a thermometer placed in the focus of a thermoscope. The general circumstances of this night were apparently the same as those of the 27th of April, at least the deposition of dew and the clearness of the atmosphere bore a strong resemblance to it; still no mist was perceived, the temperature of the atmosphere having in no case fallen below the temperature of the ground.

On the 13th of June, at 5¾ P.M., a mist began to form on the sea, and in a short time it rapidly extended itself over the land. The following observations were made of the temperatures of the air and land.

Time.	Temperature of the Ground.	Temperature of the Air 5 Feet above the Ground.
6¼ P.M.	70°	63°
6¾ P.M.	67	62
7½ P.M.	65	62
9½ P.M.	65	64
	Maximum Cold during the Night.	Maximum Cold during the Night.
	62°	62½°

The mist appeared the greatest at the time the first temperature was determined, which was about half an hour after it was first observed. Its density diminished during the two succeeding observations; and it will be found from an inspection of the above table, that the *excess* of the temperature of the ground *above* that of the air likewise decreased. At half-past nine, the mist was changed into gentle rain, the thermometer at the same time indicating only a difference of a single degree. During the night, it appears, from the maximum degrees of cold, that the register thermometer in the air was half a degree higher than that on the grass.

At the time the temperature was first observed on the land, a simultaneous observation was made by a friend, on the sea, and the results were the following:

Time.	Temperature of Sea.	Temperature of the Air 5 Feet above the Sea.
6h. 15′ P. M.	66°	63°
Time.	Temperature of Land.	Temperature of Air 5 Feet above the Land.
6 h. 15′ P.M.	70°	63°

With respect to the observations contained in the last table, it may be observed, that one of the conditions necessary to the formation of mist in abundance over the sea, according to the author of the paper before quoted, is the degree in which the temperature of the water *exceeds* that of the air; and it is not improbable but that the excess of the temperature of the land *above* that of the sea, the temperature of the atmosphere reposing on each being precisely the same, was the cause which led to the rapid passage of the mist from the sea to the land, as observed at the commencement of the observations.

For several of the latter days of August, some fine masses of moving mist were observed, early in the evening, floating over the sheets of water, and other moist places in the marshes before alluded to. On the 27th, between eight and nine, a beautiful stratum of it was seen hovering over a part of the stream which supplies the town with water. The mist moved in the direction of the running stream, but with a velocity much greater. It also accommodated itself in a most singular manner, in its course, to all the turns and windings of the channel. The breadth of the moving column was nearly the same as that of the stream, and its average altitude about five feet. The following observations were made on it.

Time.	Temperature of the Water.	Temperature of the Air over the Water.	Temperature of the Ground near the Mist.	Temperature of the Air above it.
9 P.M.	56°	47½°	45°	49°

The relations of these temperatures are exceedingly curious. The temperature of the water being *greater* than that of the air above it, was the cause of the formation of the mist;—and the temperature of the ground being *below* that of the air which reposed on its surface, was also the cause why no mist was observed over its surface. The mass of air over the water was 8½ degrees *colder* than the stream; whereas the air on the borders of the channel was 4° *warmer* than the ground on which it reposed.

Early in the month of September, at about 2 P.M., immense masses of mist rolled in from the sea, filling the whole of the harbour, and covering a portion of the surrounding land. At three, the greater part had disappeared; but a fine column of it was observed in a perfect state of repose, over the bosom of the creek which runs up to the little village of St. John's, at the entrance to Hamoaze. Having taken a boat, for the purpose of performing a few experiments, I found the temperature of the air near the shore to be 68°, and the water 63°. On approaching the mist, however, a depression of temperature was gradually perceptible, and the thermometer was found successively to indicate 65°, 64°, and 63°;—and when the boat was rowed into the centre of the mist, the temperature was found to be 62°, and that of the water about 63½°. On retiring from the mist, an elevation of temperature was immediately perceptible, the mercury standing at 64°; and by proceeding to a still greater distance, the temperature successively increased to 65° and 67°, being within a degree of what it was on leaving the shore. The column of mist soon afterwards disappeared.

On the 13th of November, at 6 A.M., a very dense mist covered the neighbouring land and water, rising above the highest of the surrounding hills. At 8 A.M., I had occasion to cross the river Tamer, the mist still shrouding the whole of its surface, and that of the adjacent country. The part crossed was about a mile in breadth, and many opportunities therefore presented themselves, of estimating the temperatures of the sea and mist. On the eastern border of the river, the air was 42°;

and for about 300 yards across, the air reposing on the water, preserved the same temperature. Towards the middle of the river, however, the temperature of the air was only 41°; but on approaching the western shore, it was found gradually to increase to 43°. This depression of temperature in the middle of the mist, most strikingly accords with the view Sir Humphry Davy has taken of the increase of mists after their first formation;—and which he accounts for by supposing, that the increase depends not only upon the constant operation of the cause which originally produced them, but likewise upon the radiation of heat from the superficial particles of water composing the mist, *which produces a descending current of cold air in the very body of the mist*, whilst the warm water continually sends up vapour. The temperature of the river was 53°, both near its shores, and in the middle.

The land beyond the western side of the river, is hilly and unequal; and accordingly the temperature of the air was found to vary from 43° to $39\frac{1}{2}$°. The air in the fields close to the river was 42°; on higher land it amounted to 43°, and in the valleys and lower grounds, it varied from 41° to $39\frac{1}{2}$°.

At a quarter past nine, the mist still continued, and so dense, as totally to obscure the sun. The temperature of a rivulet was found to be 51°, being two degrees colder than the water of the river; and the air above it 40°, also two degrees colder than the medium temperature of the air reposing on the Tamer. At the same moment, the temperature of a meadow was found to be 44°, and of a ploughed field 46°. At half-past nine the mist suddenly disclosed the sun, when the air above the same meadow was found to be 42°, and the green soil 46°. At noon, the mist had disappeared, and the temperature of the air, both over the land and sea, was 55°, the river preserving the temperature of 53°, the same as early in the morning.

During the afternoon of the 10th of June, a dense mist had formed, which covered the beautiful hill of Mount Edgcumbe, and also completely concealed from view, the Breakwater, the ships in the Sound, and Hamoaze. Circumstances prevented me from attending to it during the afternoon;—but at half-past seven, finding the mist rapidly disappearing, I went on the water, and found, that as the temperature of the air increased, so the mist diminished. The first observation found the temperatures of the air and water the same, each being 62½°; but when the air increased to 63½° and 64°, the mist melted rapidly away. This phenomenon accords most perfectly in principle with the observation made by Sir Humphry during his voyage on the Danube,—that the disappearance of mist results from an elevation of the temperature of the air.

Examples have occurred during the past summer, of mists existing in a very dense state, over water, in the morning, when the difference in the two temperatures has only amounted to two degrees; and in one instance indeed, a remarkably dense mist was examined, when its temperature was only one degree *below* that of the water. To produce a mist, in the first instance, it appears, from the experiments of Sir H., that the air must be cooled from three to six degrees *below* the temperature of the water. After, however, it has once been formed, it may exist for a considerable time, after the air has gained such increments of heat, as to reduce the difference between the temperatures of the air and water to a very small quantity. Between the first formation of a mist, and its final disappearance, it is evident, from the principles laid down, that a moment must exist, when the temperatures of the air and the water will exactly coincide. Before this period, the principle which promoted the formation of the mist, may sometimes continue in operation, but with a diminished activity, until an equality of temperature is attained;—but after this, the mist will disappear, with a rapidity proportional to the magnitude of the increments which the atmosphere may receive. The continuance of the mist (omitting the consideration of the radiation of heat from the superficial particles of water composing the mist) must be regulated by the difference between the temperature of the air and water; and which, from the diversified nature of our atmospheric changes, will be exceedingly varied and uncertain.

The following table contains an abstract of some results recorded, at my request, by a scientific friend *, and which perfectly accord with the luminous views of Sir H Davy.

Mouth and Day.	Temperature of Air.	Temperature of Water.	REMARKS.
	°	°	
June 11	59	63	Thick mist.
August 3	59	59	Thick mist.
4	52	59	Thick mist.
6	54	59	Moderate mist.
7	56	59	Thin mist.
8	54	60	Mist and gentle rain.
28	58	62	Do. do.
31	49¾	61¼	Very dense mist.
Sept. 3	57¾	61	Thin mist.
4	56	61	Thin mist.
10	53	59¾	Dense mist.
12	54	60	Do. do.
24	58	59	Very dense mist.
28	51	58	Moderate mist.
Oct. 4	53	59¾	Very dense mist.
11	48	55	Moderate mist.
15	46½	57	Very dense mist.

All the preceding observations were made at 7 A.M., excepting the first, which was at 6 A.M.

Some instances also have occurred, to illustrate a remark made by Sir H. Davy, that a current of dry air passing across a river will prevent the formation of mist, even when the temperature of the water is much *greater* than that of the atmosphere; and he adduces an example of the Danube having no mist on its surface, when the temperature of the river was 61°, and the air only 54°; the cause of which he attributes to the prevalence of a strong easterly wind. The following are some examples which occurred during the past summer:—

Month and Day.	Temperature of Air.	Temperature of Water.	REMARKS.
	°	°	
July 13	58	61	Atmosphere clear. Gale from N.E.
30	58	63	Atmosphere clear. Gale from E.
Sept. 14	56	59	Cloudy. Gale from E.
19	58	60	Clear. Gale from E.
21	54	59	Cloudy. Brisk Gale from E.

These observations were also made at 7 A.M.

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* Mr. George Pridham.

It may also be added, that the temperature of the air is sometimes considerably less than that of water, during rain. The following are instances:

Month and Day.	Temperature of Air.	Temperature of Water.	REMARKS.
July 26	60¾°	62¼°	Clouds with Showers.
31	52¾	62	Heavy and frequent Showers.
August 2	54	59	Clouds with Showers.

The example of the 31st of July, exhibits a remarkable difference in the temperatures of the air and water.

Art. VIII. *On the Light produced by the Discharge of an Air-gun:*

To the Editor *of the Quarterly Journal of Science and the Arts.*

Sir,

Among the various methods of producing light, taken notice of by philosophical writers, that from the discharge of the air-gun has not escaped observation. It is asserted that a flash of light is seen at the muzzle of the air-gun, when it is discharged in the dark. This light is supposed to be electric, and to be produced by the sudden expansion of the condensed air in the atmosphere. Having often attempted to produce light in this manner without success, I varied the experiment by introducing successively warm, dry, and damp air; and discharging them in moist, dry, frosty and warm atmospheres; but always without succeeding in the production of light. Lest the barrel of the gun might be supposed to absorb the electric fire, I discharged the spherical magazine itself by striking with a hammer on the valve, but still without the expected success.

One evening last autumn, while discharging the same gun, during twilight in a back court, I observed for the first time a faint light. I now concluded that it must be from the wadding exciting friction on the inside of the barrel (all the former experiments having been made with an unloaded gun). But, as

I could not re-produce the light that evening, I imagined that the first wadding (made of paper,) had been drier and a better electric.

I now tried dry silk, woollen, feathers, paper, rosin, shell-lac, sugar, as well as tubes, and narrow slips of glass.

The first three and shell-lac occasionally produced light; sugar and glass never fail to do so; but that from the glass was by far most vivid, affording a stream of bright greenish-coloured light, extending about a foot in length from the muzzle. Imagining that it was the velocity with which the electric substance was driven through the air that occasioned the phenomenon, I enclosed small lead shot, peas, &c., in pieces of silk, leaving a tag of silk behind. By this contrivance I expected to produce a luminous stream, but I could perceive no light whatever from any of them.

The preceding experiments were made in the cellar of a half-finished house. I repeated them before some friends on the following evening, with the same success. But what was our surprise on trying some of the old silk wadding, which had become damp and dirty from lying on the floor since the last night's experiments, to find them yield a much more luminous appearance than before; and, that small pieces of split lath, and even damp saw-dust picked up off the floor, likewise afforded light. We now tried the gun empty or without a charge in its barrel, when we found it always to give light at the first shot, after the magazine was charged; and this took place whether the charge was high or low.

My brother remarked that some particles of lime or sand might possibly fall into the barrel, as the gun was rested against the wall, during the time that the magazine was charging; the attrition of which particles might probably be the cause why the first discharge appeared luminous. Accordingly, on taking precautions against this accident, no light could be obtained. But on introducing a little sand, a beautiful stream of light was seen at every discharge.

It was now evident that the light was produced by attrition, and that the sand adhering to the split lath, saw-dust, silk, &c., might be the real cause of the light. We next tried pieces of very clean and dry silk, wool, feathers, and cylinders of wood, carefully freed from sand, and found that no light could be excited by their means.

Finally satisfied that attrition was the sole cause of the luminous appearance, we tried siliceous and other hard bodies, which emit light on being rubbed together, such as quartz, fluor-spar, &c., and found them all to be luminous. From bodies of an opposite nature no light could be elicited. To ascertain whether the light from these hard substances might arise from small particles of iron torn from the sides of the barrel, like sparks from a cutler's wheel, we held sand, fragments of spar and sugar successively in our hands, at the muzzle of the gun, and discharged it at them. In this way they all appeared luminous, though not so bright as when discharged from the barrel. To see whether it might not be an electrical appearance, arising from the air being violently blown against these crystalline bodies, we formed a small grating of clean and well-dried thermometer tubes, which we held as before, opposite to the muzzle of the gun; but could in this case perceive no luminous appearance whatever from discharges of condensed air passed through them.

Hence it may be concluded that light emitted on the discharge of an air-gun arises solely from attrition, occasioned by sand or other hard substances adhering to the wadding, or getting by accident into the barrel; and, that no light can be produced from the sudden expansion of the air from a condensed magazine, or from its impulse on the still atmosphere*. By introducing sugar into the gun and discharging it against a wall in the dark, a flash of light is seen to proceed from the sugar, as it strikes the wall.

(Signed) JOHN HART.

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* The light which M. Biot says is extricated when we cause a glass globe filled with air to burst *in vacuo*, must be ascribed to the friction of the particles of the broken glass on each other.

ART. IX.—*Details of a Barometrical Measurement of the Sugar-loaf Mountain at Sierra Leone, and of other Heights situated within the Tropics. In a Letter from* Captain EDWARD SABINE, *of the Royal Artillery, to* J. F. DANIELL, Esq.

MY DEAR SIR,

I have much pleasure in communicating to you the accompanying detail of a barometrical measurement of the height of the Sugar-loaf Mountain at Sierra Leone, because I am enabled to add in comparison, the result of a geometrical determination of the same, which has been accomplished since I quitted Africa.

The Sugar-loaf, so called from its shape, is the highest point of the mountain district of the colony, included as yet within the limit to which cultivation has extended. This district, as you are aware, is the site of the twelve most interesting settlements of liberated Africans, from the principal of which, Regent-town, it is distant about three miles, being altogether about eight or nine from Free-town, the seat of government: a road has been opened by the inhabitants of Regent-town, by which the summit is accessible, and has been sufficiently cleared of its forest-trees to admit the view around. In the continuation of the Sierra towards the south, at about 20 miles distance, the land appears to attain a greater general elevation than in the neighbourhood of the Sugar-loaf, and there are several points, especially, which are probably much higher; to these there is as yet no road, but from the very rapid advance which the colony is making in population and in settlement, it cannot be doubted that these points must very shortly be necessarily included in the Colonial Survey.

Dr. Nicol, deputy-inspector of army hospitals, was kind enough to allow me the use of a stationary barometer, in excellent order, made by Cary, and the property, I believe, of the College of Physicians; it is the same instrument which has since accompanied Captain Laing in his very interesting excursion to the Soolima country, in which the Niger takes its rise, and which has enabled him to ascertain satisfactorily the elevation at which that river originates its yet unknown course. The accordance of the portable barometer with the stationary was examined before and after the observations for the measurement; the latter was placed in the room in Fort Thornton, in which my pendulum experiments were made, and its height, consequently, above half tide, carefully ascertained by levelling, was known, with tolerable precision, to be 190 feet; the variations in the density and temperature of the atmosphere, and in the point of deposition of moisture as indicated by your hygrometer, were observed at this spot by Captain Laing, at stated periods with a chronometer, on the 28th of March, so as to be simultaneous with such as should be made at elevations.

I shall confine myself to stating the data necessary for the calculation of the heights of the clergyman's house at Regent-town, and of the summit of the Sugar-loaf. At the first of these stations, the barometer, having been suspended above an hour five feet below the gallery which surrounds the clergyman's house, shewed at 7 A.M. on the 28th March, 29.017 in., th. 74°.5, and the point of deposition 57°; the corresponding observations at Fort Thornton were 29.820 in., th. 79°.5, and the point of deposition 66°. At 11 A.M. on the same day, the barometer being suspended in the shade, at the summit of the Sugar-loaf, the cistern 1½ feet below the highest point, was suffered to remain until 12 o'clock, that the mercury might acquire the temperature shewn by the attached thermometer; when the observations registered were 27.560 in., th. 82°.2, and the dew point 70°,—those at Fort Thornton being 29.795, th. 84°, and the dew point 70°, also.

The mercury being reduced to the same temperature at the upper and lower stations, and $\frac{1}{68}$ of the differences in the heights of the column being added on account of the respective diameters of the tube and cistern of the barometer, the true differences are, between Fort Thornton and Regent-town .8 in., and between Fort Thornton and the Sugar-loaf 2.263 in., at the temperatures of the air, and under the pressure of the amount of atmospheric vapour specified above. The approximate heights due to these differences being corrected for the latter circumstances, in the manner and agreeably to the tables which you have given in the XXVth Number of the *Quarterly Journal of the Royal Institution*, it results that the floor of the gallery of the clergyman's house at Regent-town is 983.6 feet, and the summit of the Sugar-loaf, 2521.6 feet above the sea.

I have taken the liberty to add (though without permission) an extract of a letter which I have received, since my return to England, from Thomas Stuart Buckle, Esq., engineer and surveyor of the colony, stating the result of a comparative geometrical measurement. "I was much gratified to find, on computing the altitude of the Sugar-loaf, from the trigonometrical observations that I had taken, that the result differs from your barometrical measurement only a few feet; I make its height 2493 feet: the height of Leicester Mountain I computed to be 1954, and it was sufficiently satisfactory, on taking into account the distance of the Sugar-loaf from Leicester Mountain, and the excess of its height above that of Leicester Mountain, that the result of the latter was 537 feet, which, added to 1954, amounts to 2491, differing from the former calculation only two feet."

I have added the barometric measurements of well-known places in the islands of Ascension, Trinidad, and Jamaica; but I am not aware of any previous results with which to compare them.

Height of the Mountain-house at Ascension.—July 9th, 1822, at $9^h\ 30^m$ A.M., a barometer, 17 feet above the sea, in a room in the Barrack-square at Ascension, stood at 30.165 in., the temperature of the air and mercury being 83°, and of the point of deposition 68°; whilst, at the same time, another barometer three feet above the floor of the Mountain-house, stood at 27.950 in., the air and mercury 70.3, and the point of deposition 66.5. From these data, the floor of the Mountain-house would appear 2221.8 feet above the sea.

The upper barometer was then taken to the summit of the island, but the registry at that height has been mislaid; it was 27.3 and some hundreds, being less than 700 feet above the Mountain-house; consequently, the highest part of Ascension is under 3000 feet: on returning from the summit, the barometer was replaced three feet above the floor of the house, and allowed to remain until the mercury should have acquired the temperature of the air, when, at 1h 30m P.M., its height was 27.937 in., air and mercury 72°, point of deposition 68°, and in the lower barometer 30.137 in., air and mercury 84.5, point of deposition 71°, whence the height of the floor of the Mountain-house results 2219 feet above the sea, being three feet less than the first measurement. The mean, consequently, or 2220.5 feet, is considered the correct elevation.

Height of the Block-house at Fort George, Trinidad.—October 9th, 1822, at 8h 30m A.M., a barometer, 4½ feet above the foundation of the Block-house, stood at 29.000 in., the air and mercury being 76.5, and the point of deposition 76.5 also, with slight rain. The corresponding height of the barometer, at the same time, in the Protestant church in Port Spain, 20 feet above the sea, was 30.058 in., air and mercury 82°, and the point of deposition 77°. Whence the foundation of the Block-house would appear 1067 feet above the sea.

Height of Mr. Robert Chisholm's house, in the Port-Royal Mountains, Jamaica.—October 31st, at 4h 30m P.M., a barometer, suspended against the wall of Mr. Chisholm's house, 2 feet above the ground, stood at 25.967 in., the air and mercury being 68.5, and the point of deposition 68.5 also; and on the 2d of November, at 6 A.M., at 25.963 in., the air and mercury 65°, and the point of deposition 60°. The corresponding observations at Port Royal, at the same hours, 8 feet above the sea, were—

Oct. 31,—Bar. 30.007; Air, 82.5; Merc., 84.5; Dew point, 77
Nov. 2, „ 30.023 78. 78. 72

Whence the height of the ground on which Mr. Chisholm's house stands, results respectively, 4087.9 feet, and 4072.7 feet, the mean being 4080.3 feet above the sea.

All the observations at heights were made with the same portable barometer; $\frac{1}{68}$, therefore, is added throughout to the barometric differences on account of the ratio of the diameters of the tube and cistern. The height of the column of mercury, in the upper and lower barometer, under equal pressure, was in all cases carefully examined, and the difference, if any, allowed as an index error to the lower barometer. I have great pleasure in remarking, that I found much less difficulty than I had anticipated, in getting corresponding observations made with the hygrometer, on the correctness of which I could sufficiently depend; the ingenuity in the principle of this instrument, and the simplicity of its application, together with the decisive nature of the results which it gives, independent of the labour, and at best, the uncertainty of formulaic deduction, form its great advantage over the methods by evaporation, or the indications of hygroscopic substances: these particulars excite an interest in its trial in persons to whom it was previously unknown, which is probably the reason that the distrust, which is almost always in the first instance expressed of precision in the observation itself, is found to give way in practice so much sooner than might be supposed. It may be useful, also, to travellers in warm climates, to add a remark from my own experience, that in ascending elevations, or in journeying inland over rough roads, the ether carries perfectly well in a bottle in the waistcoat pocket, with a common cork capped with leather; and that the expenditure of ether altogether will probably fall much short of the estimate, as, with ordinary care, very little will be wasted.

Believe me, my dear Sir,
Very sincerely yours,
EDWARD SABINE.

LONDON, March 17, 1823.

ART. X. *On Hydrate of Chlorine.* *By* M. FARADAY, *Chemical Assistant in the Royal Institution.*

IT was generally considered before the year 1810, that chlorine gas was condensible by cold into a solid state; and we were first instructed by Sir Humphry Davy, in his admirable researches into the nature of that substance, published in the *Philosophical Transactions* for 1810-11, that the solid body, obtained by cooling chlorine gas, was a compound with water;

and that the dry gas could not be condensed at a temperature equal even to −40° Fahr., whilst, on the contrary, moist gas, or a solution of chlorine in water, crystallized at the temperature of 40° Fahr.

M. Thenard, in his *Traité de Chimie*, has described the deposition of the hydrate of chlorine by cold from an aqueous solution of the gas. It forms crystals of a bright yellow colour, which liquefy when their temperature is slightly raised, and in so doing give off abundance of gas.

This substance may be obtained well crystallized, by introducing into a clean bottle of the gas, a little water, but not sufficient to convert the whole into hydrate, and then placing the bottle in a situation the temperature of which is about or below freezing, for a few days: and I have constantly found the crystals better formed in the dark than in the light. The hydrate is produced in a crust or in dendritical crystals; but being left to itself, will in a few days sublime from one part of the bottle to another in the manner of camphor, and form brilliant and comparatively large crystals. These are of a bright yellow colour, and sometimes, though rarely, are delicate prismatic needles extending from half an inch to two inches into the atmosphere of the bottle: generally they are of shorter forms, and when most perfect and simple, have appeared to me to be acute flattened octoëdra, the three axes of the octoëdron having different dimensions.

Though a solution of chlorine deposits the hydrate when cooled, yet a portion remains in solution, and the crystals also dissolve slowly in water. It is, therefore, soluble, though not so much so as chlorine gas. When a solution of chlorine is cooled gradually till the whole is frozen, there is a perfect separation of the hydrate of chlorine from the rest of the water, or rather from the ice; for crystals of ice, formed in a solution of chlorine, when washed in pure water, and then dissolved, do not trouble nitrate of silver.

I neglected to ascertain the specific gravity of the crystals whilst the weather was cold and they were readily obtainable; but, I have endeavoured since to do so by means of cooling mixtures. The hydrate in thin plates, was put into solutions of muriate of lime of different densities, but of the temperature of 32° Fahr. It seemed to remain in any part of a solution of specific gravity 1.2, but there was constantly a slight liberation of gas; and, as minute and imperceptible bubbles may have adhered to the hydrate, the result can only be considered as a loose approximation. The solid crystals would probably be heavier than 1.2.

The hydrate of chlorine acts upon substances, as might be expected, from the action of chlorine upon the same substances, and it may perhaps now and then offer a convenient form for its application in experiment. When put into alcohol, an elevation of temperature amounting to 8° or 10° took place. There was rapid action, much ether, and muriatic acid formed, and a small portion of a triple compound of chlorine, carbon and hydrogen.

When put into solutions of ammoniacal salts it liberated nitrogen gas, formed muriatic acid, and also chloride of nitrogen, which remained undissolved at the bottom of the solution. In aqueous solution of ammonia similar effects were produced, but less chloride of nitrogen was formed.

In order to arrive at a knowledge of the composition of this substance, I adopted the following process. The crystals were collected together by a small quantity of solution of chlorine, then filtered and pressed between successive portions of bibulous paper, at a temperature of 32°, (care being taken to expose them as little as possible to the air,) until as dry as they could be rendered by this means. A glass flask with a narrow neck, and containing a portion of water at 32°, having been previously counterpoised, a portion of the crystals were immediately after the last pressing introduced into it; they sank to the bottom of the water, and the flask being again weighed, the quantity of crystals introduced was ascertained. A weak solution of pure ammonia was then poured on the water in the flask, care being taken to add considerable excess over that required by the chlorine beneath. The whole was left for twenty-four hours, in which time the chlorine had had sufficient opportunity to act on the ammonia, and any portion of chloride of nitrogen that might at first have been formed would be resolved into its elements, and its chlorine be converted into muriatic acid. It was then slightly heated, neutralized by pure nitric acid, precipitated by nitrate of silver, and the chloride of silver obtained and weighed.

The following is an experiment conducted in this way: 65 grains of the pressed crystals were put into the flask, and the ammonia added; at one time there was a faint smell of chloride of nitrogen for an instant at the mouth of the flask, and a little more ammonia was added. The next day 73.2 grs. of chloride of silver were obtained from the solution, and if this be considered as equivalent to 18 grs. of chlorine, then the 65 grs. of hydrate must have contained 47 grs. of water, or per cent.

Chlorine . . .	27.7
Water	72.3.

This nearly accords with 10 proportionals of water to 1 of chlorine, and I have chosen it because it gave the largest proportion of chlorine of any experiment I made. It is evident that any loss or error either in the drying the crystals, or in the conversion of the chlorine into muriatic acid by the ammonia, would tend to diminish the proportion of that element, and it is even possible that the above proportion of chlorine is under-rated, but I believe it to be near the truth. The mean of several other experiments gave

Chlorine . . .	26.3
Water	73.6.

Note.—Since writing the above, Mr. Faraday has succeeded in condensing chlorine into a liquid: for this purpose a portion of the solid and dried hydrate of chlorine is put into a small bent tube and hermetically sealed; it is then heated to about 100, and a yellow vapour is formed which condenses into a deep yellow liquid heavier than water, (sp. gr. probably about 1.3). Upon relieving the pressure by breaking the tube, the condensed chlorine instantly assumes its usual state of gas or vapour.

When perfectly dry chlorine is condensed into a tube by means of a syringe, a portion of it assumes the liquid form under a pressure equal to that of 4 or 5 atmospheres.

By putting some muriate of ammonia and sulphuric acid into the opposite ends of a bent glass tube, sealing it hermetically, and then suffering the acid to run upon the salt, muriatic acid is generated under such pressure as causes it to assume the liquid form; it is of an orange-colour, lighter than sulphuric acid, and instantly assumes the gaseous state when the pressure is removed. Sir H. Davy has given an account of this experiment to the Royal Society. It is probable that by a similar mode of treatment several other gases may be liquefied.

Art. XI. *An Account of a Barometrical Measurement of the Height of the Pico Ruivo, in the Island of Madeira. Extracted from a Letter written by* Captain Edward Sabine, *of the Royal Artillery, to* Sir Humphry Davy, Bart., *President of the Royal Society, dated in January,* 1822, *on board his Majesty's Ship Iphigenia, on passage between the Cape Verd Islands and Goree.*

" You are probably aware that the mountainous parts of the interior of Madeira have been rendered accessible to a greater distance than formerly, by roads of recent construction, passable at most seasons by mules, or by the small horses of the island, which vie with mules in the sureness of their footing. I availed myself of the opportunity which our short stay afforded, of making an excursion to the summit of the Pico Ruivo, the highest of the island, with a view to obtain a measurement of its height, and to make a first essay with a portable barometer having an iron cistern, on which Mr. Newman had bestowed much pains, to obviate the liability to the various errors to which these instruments are generally subject. The party consisted of Captain Clavering, of his Majesty's ship Pheasant, Mr. Whitelaw, surgeon of the Iphigenia, Mr. George Don, naturalist of the Horticultural Society, and two midshipmen of the frigate; we were accompanied by Mr. Blackburne, an English merchant resident at Madeira, who, having before ascended the Peak, was kind enough to undertake to conduct us, and by his local knowledge and authority over our Portuguese attendants and guides, as well as by his own enterprising spirit, enabled us finally to accomplish our purpose. Lieutenant Stokes, of the Iphigenia, was so kind as to remain on board the frigate throughout the day, to note the variations in temperature and density of the atmosphere, and of the point of deposition indicated by Mr. Daniell's hygrometer. These were observed hourly by a chronometer, so as to be simultaneous with others which we should make at the heights at which we might find ourselves. I shall detail the observations, and their computed results, at the close of the letter, and purpose to give you a slight sketch of our route, such as may possibly be useful to persons desirous of making a similar excursion.

We quitted Funchal before day-break, and proceeded about six miles along the coast to the westward to Camera de Loubos, from whence we commenced the ascent in a northerly direction. At eight we stopped to breakfast at the Jardim de Serra, a house which Mr. Veitch, the British consul-general, has built, at an elevation of nearly 2800 feet. In approaching this height, the vegetation reminded us at every step of England; the people of the country, whom we met on their way to mass, impressed us favourably by their courteous demeanour towards each other, as well as to strangers; they were well, and even handsomely clothed; the men able-bodied and good-looking, but the women, almost without exception, very plain.

We found the temperature at Mr. Veitch's 16° less than at Funchal, being a much greater difference than we had expected as due to the elevation. An ascent of about half an hour from the Jardim opens the first sight of the Curral, which struck me, who am, however, but little accustomed to mountain scenery, as the most magnificent view I had ever seen; the Curral das Freiras, which means literally, I believe, the Sheepfold of the Nuns, is a ravine extending several miles in a north and south direction, and of considerable width, the sides extending four thousand feet in height, in character frequently precipitous, and where so, being in fine contrast with the deep green foliage of the trees, by which the sides are more generally clothed; these trees are principally laurels, amongst which we noticed the Nobilis, Indica, and Fœtens. The valley of the Curral is occupied by a small river, which descends from the high land of the interior with all the character of a mountain torrent. Our route led into the Curral for the purpose of ascending its valley, but the descent being impracticable at the spot where the first view is obtained, the road continues to ascend, passing over an elevated ridge, on which there was much snow. In descending on the Curral side of this ridge, and at some distance beneath its summit, is a copious spring, which collects in a shaded basin formed in the rock by the workmen by whom the road was made. The temperature of the water in this basin was 47°.2, that of the air 46°, and at Funchal 65°; its elevation 4454 feet.

Whilst these observations were making, the summit of the Pico Ruivo, which was enveloped in clouds during the day, was visible for some minutes; and it may be worthy of notice, that this was the only period in which the proportion of moisture in the upper air to saturation was observed to be less than at Funchal. The wind throughout the day was easterly and light, but with little of the unpleasant sensation which usually characterizes the *Leste.*

The time pressing, we committed our horses to the Portuguese attendants, and descending ourselves on foot more quickly than we should have done on horseback, although stopping occasionally in admiration of the splendid scenery on every side, which it was impossible to pass without notice, we crossed at noon the Ribeiro di Curral on a tree which had fallen across the torrent, the horses fording it lower down, and pursued a road which led to the head of the valley. We there recommenced the ascent, and passing through districts of brooms and ferns, entered the snow at a somewhat lower elevation than on the heights near the coast. At two P.M. we reached the highest point attainable on horseback, by reason of the depth of snow, and of the frequent quebradas, or breaches, in the road, caused by the descent of torrents. It is a ridge 4380 feet above the sea, over which the road passes at the foot of the Pico das Torrinhas, which is inferior in height only to the Pico Ruivo. From hence Mr. Whitelaw and myself proceeded on foot, the others of our party returning to the valley to await us. Entering a thick wood of evergreens, consisting of laurels, of the Quercus Ilex, and of the Erica Arborea which attains a large size and grows even at the summit of the mountains, we were soon enveloped in the clouds by which the Peak was hid from our sight; and after an hour and a half's good walk through snow, which latterly exceeded two feet in depth, impeded occasionally by the quebradas, which are passable only by the aid of roots and branches of trees, and not without danger, as a slip unrecovered would generally be fatal, we attained the summit. We experienced no other inconvenience than being wet by the rain, and a little cold, whilst we remained to make the necessary observations to ascertain the height; certainly none that need deter others from a similar undertaking at the same season of the year, when, should the weather be clear, they will be amply repaid. The Peak being nearly in the centre of the island, the view from it must be very splendid, though of this we were only able to form an imperfect judgment from the unfavourable circumstances of the weather. It is not otherwise interesting than as relates to its height and situation, being merely one of several pinnacles in an island of volcanic formation.

It was dark before we had rejoined our party in the valley. We had then to reascend the opposite side of the Curral to that which we had descended in the morning, in order to gain a nearer road to Funchal than by the Jardim de Serra. This ascent was more precipitous than any we had yet traversed, and made those amongst us feel nervous who had not learned from habit to confide in the sure-footing of the horses, inasmuch as, during the greater part of the way, a single false step would have precipitated the horse and rider many hundred feet into the valley beneath; the apprehensions of danger were perhaps augmented by the accompaniment of torch-light, and induced some of the party to trust to themselves rather than to the horses; we all, however, reached Funchal in safety by midnight.

The barometer was found to answer extremely well, both in conveyance and in use. I am not aware of any objection to the iron cistern to counterbalance its many advantages over those of leather or of wood, the former of which are especially faulty in being affected by damp, whilst the certain freedom of the mercury from air and moisture in barometers of this construction, give them a decided preference over those which are filled on the spot, and which I cannot consider as otherwise than very uncertain. I regret extremely that I have not to occupy your attention with the more important relation of its performance in the ascent of the Peak of Teneriffe, but our departure from England had been so long delayed by contrary and tempestuous winds, that we were only able to remain seven hours at Santa Cruz. We were told, indeed, that the Peak was inaccessible in the winter season, but we had heard the same at Funchal of the Pico Ruivo. I am aware that the difficulty in the two cases does not admit of comparison, but the true interpretation is, that neither is accessible without more exertion than travellers are ordinarily disposed to bestow. Had Sir Robert Mends felt at liberty to have remained at Teneriffe for three days, we should certainly have made the attempt, and as Captain Baudin succeeded in December, I trust we should not have failed in January. The precise determination of the height of this peak is yet to be accomplished, and appears worthy of being undertaken, were it only to submit barometric measurement to the test of a more exact comparison with the geometric method, (both conducted with the precision of which modern instruments are capable,) than has yet been effected. A residence of some days at the proper season, near the summit of this remarkable Peak, which rises so abruptly, and to so great an elevation, from the middle of the basin of the Atlantic, might indeed be expected to produce many important meteorological and other results; and would certainly throw much light on the extent of variation, to which barometric measurement is liable, from varying circumstances connected with the atmosphere itself, independently of errors of instrument or observation, or of the formula by which a result is deduced; the limit within which this liability might be apprehended would appear, by a comparison of the registry of the barometer at the top and at the bottom, continued for a sufficient time.

We experienced a similar disappointment, and scarcely in an inferior degree, in passing hastily by Fuego, one of the Cape Verds. I am not aware of any good account of this very remarkable island having been published, and am surprised that it has been so little visited. It rises in a cone almost from the water's edge to an height much exceeding that of St. Antonio, which is estimated by Captain Horsburg at 7400 feet, and we had reason to conclude, from the angle which it subtended at different distances, justly estimated. The summit of Fuego was visible from the ship for two days, rising much above the clouds, and always clear; no smoke proceeded from it, although it is said to be generally burning. I cannot conceive a station more eligible for interesting experiments, connected with the relations of heat and moisture to the atmosphere.

I take this occasion to bring under your notice an inaccurate practice which prevails in our directories, and even in works of higher authority, of stating the geographical position of a bay, anchorage, or town, *generally*, instead of specifying some particular bearing in the anchorage, or spot on the shore. Madeira affords an instance which is quite in point. It is recorded in the directories that Captain Flinders found Funchal Bay in 16° 55′ 24″ W. longitude, and Captain Heywood in 16° 51′; I believe that it is just possible that a difference of longitude equal to the disagreement, may be comprised within the limit of the bay, or nearly so, although it is more probable that a considerable portion of it at least is due to an actual difference between the captains, than to the distance apart of their respective anchorages. The present notice of the directories may be sufficient to enable ships to find Funchal Bay; but it does not supply a means of comparing chronometers with correct Greenwich time, which is so important to navigators, especially at a port frequently touched at by ships bound on distant voyages. The usual passage from the ports of the Channel to Madeira is from seven to ten days, an uncertainty therefore amounting to two miles in the part of the bay for which the longitude is assigned, and which is well within the limit of the anchorage, makes a corresponding doubt in the time of eight seconds, or nearly a second a day in the rate of the chronometer; an uncertainty which is of great magnitude, when it is remembered that whatever error it occasions, is multiplied in the subsequent voyage by as many times as the number of days between England and Madeira are repeated. It would be very desirable that the geographical tables in works of authority, such as in the *Connoissance des Tems,* and in Professor Lax's *Nautical Tables,* should have an additional column, specifying the spot to which the latitudes and longitudes refer; it is otherwise quite unnecessary to give these data to seconds of space.

The precise geographical determination of some one spot in Funchal is still a desideratum, which I was in hopes of supplying by a sufficiency of lunar observations, could another day have been spared me. I may state, as an approximation, that the result of 64 distances, 40 of Regulus west, and 24 of the Sun east of the Moon, observed in the Consul's house, made its longitude 16° 55′ 00″ W.; that the three chronometers of Parkinson and Frodsham, on which I placed principal reliance, made it respectively as follows:

	° ′ ″	
No. 384,	16 57 05	By observations in the fore and afternoon, and using the rates at which they had gone in England.
493,	16 57 08	
423,	16 56 39	
Mean,	16 56 57	

and that the mean of all the chronometers I had with me, (except Brequet's whose rate had altered considerably,) made the longitude 16° 56″ 30.″

NOTE.—Since this letter was written, Madeira has been visited by his Majesty's ships Leven and Barracouta, on their passage to survey the eastern coast of Africa, under the command of Captain Owen. By the chronometers on board these ships the difference of meridians between the Marine Observatory at Lisbon, and the Loo Fort in Funchal Bay, appeared 7° 48′ 09″, whence assuming the Observatory at Lisbon at 9° 08′ 51″ W., the Loo Fort would be in 16° 57′ 00″.—And finally, the longitude of the Consul's garden at Funchal has been determined by a mean of sixteen chronometers, specially sent for the purpose, at the direction of the Commissioners of Longitude. It is understood that their mean result made the garden in 16° 54′ 52″. 5 W. The three stations are all within a second of time.

"I conclude with a detail of the observations, and the heights computed from them.

OBSERVATIONS made at MADEIRA, January 13, 1822, to determine the elevation of several Stations in the ascent to the Pico Ruivo.

STATIONS.	Observations at the Station.				Corresponding Observations 8 feet above the Sea.				Height Deduced.
	Barometer.	Temperature.		Point of Deposition	Barometer.	Temperature.		Point of Deposition	
		Air.	Merc.			Air.	Merc.		
	Inches.	°	°	°	Inches.	°	°	°	Feet.
Jardim di Serra, floor of the upper story of Mr. Veitch's house	27.681	49	49	41.5	30.603	65.	65	54	2782.6
Basin of the Spring	26.012	46	46	34	30.543	65.5	65.5	53	4453.9
Ridge at the foot of the Pico das Torrinhas	25.948	42	42	36	30.423	64	64	56	4379.7
Summit of the Pico Ruivo. The observations were made eleven feet below the summit, but the computed height is that of the summit itself.	24.938	36	36.5	36	30.423	61.5	61.5	58	5438.1

The results have been deduced in the manner explained in Mr. Daniell's paper, " On the Corrections to be applied in Barometric Measuration," published in No. XXV. of the *Quarterly Journal of the Royal Institution;* the barometric differences have been augmented by $\frac{1}{68}$th, as 68 inches of mercury in the tube are equivalent to one inch in the cistern; and $\frac{1}{500}$ of the approximate result has been added, as a correction due to the variation in density of the atmosphere, in the latitude of Madeira."

ART. XII. *Analysis of a New Sulphur Spring at Harrogate, by* WILLIAM WEST, Esq.

[Communicated by the Author.]

AN exact acquaintance with the composition of the water of mineral springs is, in many respects, highly important; without it we can scarcely derive the full benefit from their medicinal employment; it throws light on geology, and on the chemistry of nature, and may hereafter furnish us with hints for the improvement of various processes in the Arts.

Indeed, that the truth of this remark is generally felt by the chemist and the physician is obvious, from the pains which have been bestowed upon the improvement of the means for their analysis, as well as the examination of the water of particular springs. That in neither of these respects, however, have we attained the requisite degree of certainty, is evident from the fact that, in comparing two sets of experiments on any mineral water, made by different persons, we find, in all cases, a considerable difference in the results. If it be said, that this arises from the water of the same spring being differently impregnated at different times, I reply, that it sufficiently proves our present deficiency, and should stimulate our diligence to observe that we have no means of proving how far this is really the case, or of distinguishing, with certainty, how much of the discrepancy so obvious between various reports of analyses is owing to real differences in the water, how much to defective formulæ, and how much to negligence or mistake in their application. Probably on this, as well as on many other subjects, we have begun to generalize too soon; theories of the origin of mineral springs, and of their effect in the cure of disease, have been more abundant than the *facts* ascertained respecting them would warrant; the stock of careful analyses must be augmented before those theories can be either confirmed, or satisfactorily disproved.

It is with this view that I am induced to make public the following analyses: the results which I obtained in the case which admits of comparison with others, differ materially from their statements; the account which I have given of the means used will enable the reader to form some idea of their probable correctness.

The water of the Old Sulphur Well, at Harrogate, is of undoubted and extensive efficacy in a variety of complaints: with a view to secure for general benefit the enjoyment of its advantages, it is provided, by act of parliament, that the well shall remain unenclosed, and it accordingly remains, covered only by a cupola, open on all sides, and supported by very rude pillars. This, while it secures the intended object of admitting all who come to the free use of the water, is attended with very serious inconveniences, such as the impossibility of excluding improper persons, and the occasional occurrence of accidental or mischievous impurities. To guard against these, as well as to secure a more ample supply, various attempts have been made to obtain a water of the same description, in other spots in the neighbourhood; none of these have been perfectly successful, until lately, when a well (the fourth dug there), has been discovered in the grounds of Joseph Thackwray, at the Crown Inn; this furnishes a water more highly impregnated, but which is said to sit more easily on the stomach.

To analyze this water was the object of my journey to Harrogate. I was induced, for the sake of comparison, to examine again the water of the Old Well.

Analysis of Water from the New Well at Harrogate.

The water, when fresh pumped up, is perfectly transparent, and very sparkling; the temperature was 43.5°., that of standing water, exposed to the air, being 37°.

The smell is powerfully sulphureous, the taste sulphuretted, and strongly saline—a mixture of flavours, however, to which the palate soon becomes accustomed, and which even appear to reconcile each other. On standing it becomes turbid and opalescent.

When boiled in an earthen vessel it loses its smell almost entirely, and the surface is covered with small crystals. It discolours and corrodes metallic vessels.

The specific gravity of the water is 1.01216 at 49°. equivalent to 1.0128 at 60°. This would indicate, by Kirwan's formula, 198.5 of solid matter in each quart.

The quantity obtained by evaporation from a quart was, in three trials, 211 grains.

The water restored the colour of litmus paper slightly reddened.

With nitrate of silver it produced an abundant dense precipitate, of a deep brown colour, and a highly iridescent pellicle.

With sulphate of silver, an olive brown precipitate.

With muriate, nitrate, and acetate of barytes, no change takes place; the water remains perfectly bright.

Oxalate of ammonia; abundant precipitate.

Tincture of galls Ferrocyanate of potash Sulphocyanic acid	No change.

Carbonate of potash; a precipitate.

Lime water; a precipitate.

Barytes water; slight precipitate.

Acetate of lead; very copious precipitate, of a dark brown colour.

The precipitated carbonate of lead becomes quite black when diffused through the recent water.

Tincture of soap; an abundant curd.

Carbonate of ammonia caused no precipitate, nor did phosphate of soda; but, on applying these tests in succession to the same portion of water, a considerable precipitate took place.

By these tests it is shewn, that the water examined contains sulphuretted hydrogen and carbonic acid gases, muriatic acid in combination with lime, magnesia, and an alkali; *no* sulphuric acid, *no* iron.

A wine pint of the water, previously boiled and filtered, yielded, when treated with nitrate of silver, a white precipitate, which, when washed with distilled water and dried, weighed 229.4 grains.

The crystalline pellicle, which separated from a quart on boiling, weighed 2.2 grains; it entirely dissolved in acetic acid.

One quart of the recent water was boiled with subcarbonate of soda; the precipitate, (22.7 gr.) well washed, and treated with sulphuric acid. On digesting the sulphates in a few drachms of water and again drying, the sulphate of lime remaining weighed, after ignition, 18.7 grs., equivalent to 7.7 lime, or 17.85 muriate of lime.

The sulphate of magnesia, when evaporated and dried at a heat approaching to redness, weighed 11.3 grains, equivalent to 3.75 magnesia, or 10.75 muriate of magnesia.

The mixture of salts (211 grains) was digested in alcohol, to separate the earthy muriates; what remained was muriate of soda.

To separate the gaseous contents of the water, 56 cubic inches were boiled until the quantity of gas received ceased to increase; it measured 7.95 cubic inches. This was repeated several times, and with larger quantities; nearly the same proportion was obtained.

When the whole of the gas was separated from a portion of the water, a cubic inch tube, graduated into 100ths, was filled and transferred to a bottle, containing precipitated carbonate of lead; on agitating, under water, an absorption took place, amounting to .50 of the gas operated on.

The residual gas was treated in the same manner with liquid potash, the absorption was .16 of a cubic inch.

That portion which resisted the action of carbonate of lead and solution of potash (.34. C. I.), was transferred to a detonating tube, with twice its bulk of oxygen gas, and fired by the electric spark; after this, the quantity absorbed by further exposure to potash, was .14 of a cubic inch, leaving .20, which I consider as azote.

It appears, then, that one gallon of the water in question contains, of

Sulphuretted hydrogen	6. 4	Cubic Inches.
Carbonic acid	5. 25	
Azote	6. 5	
Carburetted hydrogen	4. 65	
	32. 8.	

Which are given out in the gaseous form on boiling; also of

Muriatic acid	458. 8
Soda	345. 2
Lime	34. 8
Magnesia	15. 0
Carbonic acid	4. 0

Existing in the water as

Muriate of soda	735. 0
Muriate of lime	71. 5
Muriate of magnesia	43. 0
Bicarbonate of soda	14. 75

The results of the same means, applied to the water of the Old Well, were—of gases in one gallon,

Sulphuretted hydrogen	14. 0	Cubic Inches.
Carbonic acid	4. 25	
Azote	8.	
Carburetted hydrogen	4. 15	
	30.4	

Of solid contents.

Muriate of soda	752. 0
——— lime	65. 75
——— magnesia	29. 2
Bicarbonate of soda	12. 8

Specific gravity at 60°. 1.01324

Saline matter, by direct evaporation, 854.0

The most careful examination with tests, prepared by different chemists, discovered not the least trace of sulphuric acid, or sulphates.

On adding to equal portions of water from the Old, and that from the New Well, an equal quantity of either acetate or carbonate of lead, the eye could distinguish a difference in the colour produced, that from the New Well being a shade deeper than that from the Old.

The most remarkable difference which will be observed between the present and former statements respecting the Old Well (so far as the nature of its contents is concerned), is the total absence of sulphuric acid in any combination. I was so surprised to find this, that I hesitated to admit the inference from my first trials; but with the salts of barytes, prepared by other chemists, as well as with my own, not the slightest cloud was produced.

Should the observations of any future chemist agree with mine on this point, we must suppose, considering the respectability of those who state the existence of sulphates in the water of the Old Well (Drs. Scudamore and Garnett), this to be an established case of a mineral water varying so much, as at times to exhibit a notable quantity of a substance, at other periods wholly absent.

I apprehend no difference in medicinal power need be apprehended from the subtraction of one grain in the pint, of a neutral sulphate, whatever be its base, when supplied by a corresponding quantity of muriate.

It seems, of itself, almost a convincing proof of the identity of the general contents of the Old and the New Well, and of the stratum whence they are derived, that at the period when the latter was first examined, when no sulphuric acid could be detected, it was wholly wanting in the former, in which, on previous occasions, it had been found.

I come now to consider the gaseous contents of these waters; these agree in their nature, and nearly so in their total quantity, with those found by other chemists. Dr. Garnett found 19 cubic inches of sulphuretted hydrogen in the gallon, the greatest quantity which I obtained, even when large bubbles of gas were rising through the water in the well, was under 17 inches. Dr. Scudamore found it in the Old Well about 14 inches; the difference is not too great to impute to irregularities in the production or absorption of the gas at the spring.

The proportion of carbonic acid, found by me, differs much from the statement of Dr. Garnett, and still more from that of Dr. Scudamore. I may observe, that in about a dozen trials, the proportion was almost constant. On this point, I think some error must have crept into Dr. Scudamore's observations. He deduced the quantities of the absorbable gases from the weight of precipitate formed—a method which I tried, and found very uncertain, and which must obviously be so, since a loss or an increase of weight of one tenth of a grain in the quantity which he employed, would give rise to an error of an inch and one-third in the calculation for one gallon. Dr. Scudamore no where informs us, in a direct way, what was the total quantity of gas obtained from a gallon of the water, and the statement in p. 98 of his Treatise, 29.045, cannot possibly be the result of the experiments he has described, since none of the numbers agree with those obtained by calculation from his data; the proportion of unabsorbable gases, indeed, is but about two-thirds of that stated in p. 97.

The eudiometrical method which I pursued is short, easy and susceptible to great precision; an error in the carbonic acid, of one division of the tube, would scarcely affect .05 of a cubic inch, the quantity in a gallon.

The carburetted hydrogen, not being known to be medicinal, is of little consequence in that point of view; yet its presence in these waters is a curious circumstance, the discovery of which belongs wholly to Dr. Scudamore or his companion. My experiments fix the proportion nearly as given by them, although it seems quite unaccountable how they could arrive at it by theirs *.

To sum up the comparison between the water from the Old Well and that from Mr. Thackwray's pump,—it appears that both contain the same ingredients, solid and gaseous; that the New Well has rather the greatest impregnation of the gases; that the Old Well contains rather more common salt; while the water of the New Pump holds a considerably greater proportion of the active constituents, the muriate of lime and of magnesia.

The experiments, which occupied several days, were performed upon the spot; many were repeated several times, and through the greater part, I had the benefit of the able assistance of Dr. Murray, of Knaresbro'.

Leeds, *Feb.* 27, 1823.

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* Carburetted hydrogen gas requires for combustion twice its volume of oxygen, (Sir H. Davy's Elements, p. 306,) instead of its own bulk, as these experiments imply, and yields its own bulk of carbonic acid, instead of one-third. How were such improbable results obtained?

ART. XIII. *On the Vibrations of Heavy Bodies in Cycloidal and in Circular Arches, as compared with their Descents through free Space; including an Estimate of the Variable Circular Excess in Vibrations continually decreasing.*

By DAVIES GILBERT, Esq., F.R.S. &c. &c. &c.

To the EDITOR *of the Quarterly Journal of Science and the Arts.*

DEAR SIR,

I AM really not able to determine in what degree the following investigations may be thought worthy of attention. They were made about twenty years ago, and the impression left by them on my mind mainly contributed to my subsequently moving the House of Commons, on the 15th of March, 1816, for an Address to His Majesty, praying that directions might be given for determining the length of the Pendulum; which has led to all the important theoretical and practical discoveries of Capt. Kater, and to the highly interesting observations of Captain Sabine, and of others: on this account, at least, I may be excused for laying them before the public.

They exhibit a curious integration, by which a very simple result, conformable to that of Euler, is derived from a great apparent complexity.

The correction for variable circular excess in a free pendulum, beginning its vibrations from an arc comparatively large, and ending with one very small, differs from those already given by mathematicians; but the deductions seem to rest on solid principles.

The whole possesses one quality throughout, which, in my opinion, has not been sufficiently regarded; and that is, a strict preservation of the HARMONIA MENSURARUM.

I have constantly used the words Fluxion and Fluent, notwithstanding that I am fully satisfied with the acknowledged superiority of the new method over the old; and that the developement of functions is far preferable, as a general principle, to considerations of motion; but there appear to me no stronger reasons for changing established expressions, or notations, on that account; than might be supposed to exist for abandoning the term Calculation, because pebbles are no longer used in the operations of arithmetic.

It may be proper for me to observe, that circular excess is not noticed by SIR ISAAC NEWTON, in the sixth section of the second book of the *Principia*, treating *De Motu et Resistentia Corporum Funipendulorum.*

And I may add that neither the resistance of media, nor friction have any power to change the isochronism of an whole vibration, so long as these retarding causes continue so small, in comparison with the action of gravity, as to render their second powers insensible; since the lengthened time of descent will be exactly compensated by the diminished time of ascent.

But the specific gravities of media affect both parts of a vibration in the same way.

Let G = the specific gravity of the pendulum.

g = that of the medium, then $\frac{g}{G}$ the loss of weight;

and since the times are inversely as the square roots of the weight, the analogy will be as $\sqrt{1-\frac{g}{G}} : \sqrt{1} :: 1 : \frac{1}{\sqrt{1-\frac{g}{G}}}$ = (when $\frac{g}{G}$ is very small) to $1 + \frac{g}{2G}$.

Suppose the pendulum made of brass with a specific gravity 8.4, and that it vibrates in air the specific gravity of which, at a mean, is $\frac{1}{828}$: then will $\frac{g}{2G} = \frac{1}{13910}$, and this multiplied by 86400, the number of seconds in 24^h, will give a difference of 6″.2 between vibrations in a vacuum, and in air at the ordinary state of the atmosphere; or $\frac{2}{10}$ths of a second for each variation of an inch in the barometer; a quantity, as it would seem, not to be neglected in the present highly-advanced state of practical astronomy, whenever confidence is placed for any considerable interval, in the steadiness of the clock; and which, if it were carefully applied, would probably be found to diminish considerably, the apparent irregularities in the motion of our best time-pieces.

A variation in temperature of about 16° of Fahr. thermometer $\left(\frac{16}{480} = \frac{1}{30}\right)$ would produce an equal change with one inch of the barometer; but in the opposite direction from expansion: this, however, is obviously included as a part, in the general compensation for heat and cold.

Such as these investigations may prove to be, I place them in your hands; and it will be highly gratifying to me if I am allowed to see them honoured by a place in your Journal.

1st. The Descent through Free Space. Fig. I.

Let the line AB = 2, represent the height through which a body is supposed to fall,

T = the time.

When the part x remains to be described, the velocity will be $\overline{2-x}^{\frac{1}{2}}$. consequently $\overline{2-x}^{\frac{1}{2}} \times \dot{T} = -\dot{x}$ or $\dot{T} = \overline{2-x}^{-\frac{1}{2}} \times -\dot{x}$ $T = 2 . \overline{2-x}^{\frac{1}{2}}$ when $x = 2$ the equation vanishes, when $x = 0$ $T = 2\sqrt{2}$.

2d. The Semi-vibration in the Arc of a Cycloid. Fig. II.

Let CP the length of the pendulum = 4, applying itself to cycloidal cheeks CA and CB.

Let the diameter of the generating circle DP be = 2.

Let a = the length of the chord in the generating circle, corresponding with the cycloidal Arc Pp, through which the pendulum is supposed to vibrate; x = the length of the chord in the generating circle corresponding with the Arc Pπ remaining to be described.

Then will the velocity at the point $\pi = \overline{a\text{P} - b\text{P}}^{\frac{1}{2}} = \frac{\overline{a^2 - x^2}^{\frac{1}{2}}}{\sqrt{2}}$

And, the cycloidal Arc being double to the chord of the generating circle,

$$\frac{\overline{a - x^2}^{\frac{1}{2}}}{\sqrt{2}} \times \dot{T} = -2\dot{x} \text{ or } \dot{T} = 2\sqrt{2} \times \overline{a^2 - x^2}^{-\frac{1}{2}} \times -\dot{x}$$

$T = 2\sqrt{2} \times$ circular Arc to radius unity and cos. $\frac{x}{a}$.

When $x = a$ the equation vanishes
When $x = 0$

$T = 2\sqrt{2} \times$ quadrantial Arc to radius unity.

3d. The Semi-vibration in the Arc of a Circle. Fig. III.

Let CP the length of the pendulum $= 4$, and from C with CP as a radius, describe the vibratory circle.

Let C, as before, be the centre of a cycloid, and DP $= 2$. The diameter of the generating circle.

$a =$ the length of the chord in the generating circle, corresponding with the Arc Pp in the vibratory circle, through which the pendulum is supposed to descend.

$x =$ the length of the chord in the generating circle corresponding with the Arc Pπ remaining to be described.

Then will the velocity of the point $\pi = \overline{a\text{P} - b\text{P}}^{\frac{1}{2}} = \frac{\overline{a^2 - x^2}^{\frac{1}{2}}}{\sqrt{2}}$ as before.

To find the fluxion of the space in relation to $-\dot{x}$.

The absciss Pb in the generative circle corresponding to the chord Px will be $\frac{x^2}{2}$.

But this absciss being common to both circles, the ordinate $b\pi$ in the vibrating circle will be $\sqrt{8 - \frac{x^2}{2}} \times \sqrt{\frac{x^2}{2}} = 2x \, . \sqrt{1 - \frac{x^2}{16}}$

While x the chord in the generative circle diminishes by $-\dot{x}$ the decrement of the abscis common to both circles will be $-x\dot{x}$ and this multiplied by $\frac{\text{radius}}{\text{ordinate}} \; \frac{4}{2x \, . \sqrt{1 - \frac{x^2}{16}}}$ of the vibratory circle, will give $- x\dot{x} \times \frac{4}{2x \, . \sqrt{1 - \frac{x^2}{16}}} =$,

$\frac{2\dot{x}}{\sqrt{1-\frac{x^2}{16}}}$ the fluxion of the space, which, divided by the velocity gives $\dot{\mathrm{T}} = \frac{2\dot{x}}{\sqrt{1-\frac{x^2}{16}}} \div \frac{\overline{a^2-x^2}^{\frac{1}{2}}}{\sqrt{2}}$.

Let the first part of this expression be expanded into series, substituting b . for 16, then

$$\dot{\mathrm{T}} = 2\sqrt{2} \times \left(-\frac{\dot{x}}{\sqrt{a^2-x^2}} - \frac{x^2\dot{x}}{2b.\sqrt{a^2-x^2}} - \frac{3x^4\dot{x}}{8b^2.\sqrt{a^2-x^2}} - \frac{15x^6.\dot{x}}{48b^3\sqrt{a^2-x^2}} - \frac{105x^8.\dot{x}}{384b^4\sqrt{a^2-x^2}}\ \&c.\right)$$

$\dot{T} = 2\sqrt{2}$

&c.)

$\int - \frac{\quad}{\sqrt{a}}$

In the case of a mercurial pendulum, these quantities must be reduced to three-fifths (.6) of their magnitudes in the table.

It is then ascertained

That the time of free descent down a given line,

The time of descent down the whole or any part of a cycloidical arc of the same height by the semi-vibration of pendulum having a suspension twice as long;

And the time of a semi-vibration by the same pendulum in a circular arc, will be, in the proportions to each other of

Unity,

Unity × quadrantial arc,

Unity × quadrantial arc × $(1 + \frac{1}{2})^2 \cdot \frac{a^2}{b} + \frac{3}{8})^2 \cdot \frac{a^4}{b^2} + \frac{15^2}{48} \cdot \frac{a^6}{b^3} + \frac{105^2}{385^4} \cdot \frac{a^8}{b^4}$ &c. &c.)

Or substituting for *a*, the chord of semi-vibration in the vibratory circle, which is in magnitude double to *a*, but in reference to its own radius taken as unity, will be one half of *a*, and writing its values for *b*; the series becomes

$$1 + \frac{1}{2}\Big)^2 \cdot \frac{c^2}{2^2} + \frac{3}{8}\Big) \cdot \frac{c^4}{2^4} + \frac{15}{48}\Big)^2 \frac{c^6}{2^6} + \frac{105}{384}\Big)^2 \frac{c^8}{2^8} \text{ \&c.}$$

If *s* the sine of $\frac{1}{2}$ the arc of semivibration be substituted, the series becomes

$$1 + \frac{1}{2}\Big)^2 \cdot s^2 + \frac{3}{8}\Big)^2 s^4 + \frac{15}{48}\Big)^2 s^6 + \frac{105}{384}\Big)^2 s^8 \text{ \&c.}$$

or if $v =$ the verse sine, the series becomes

$$1 + \frac{1}{2}\Big)^2 \frac{v}{2} + \frac{3}{8}\Big)^2 \cdot \frac{v^2}{2^2} + \frac{15}{48}\Big)^2 \frac{v^3}{2^3} + \frac{105}{384}\Big)^2 \frac{v^4}{2^4} \text{ \&c.}$$

Thus far the investigations are strictly correct; but for all practical cases of vibration in small arcs, the two first terms of the series need alone be regarded, and the second only in its first power, since the third term $\frac{3}{8}\Big)^2 \cdot \frac{a^4}{b^2}$ does not amount to one second in 24 hours till the arc of semi-vibration reaches 10° 5′; nor the square of the second term till the arc is 13° 24′.

Moreover, the chord and arc in the vibrating circle may be taken as equal; for the arc in terms of the chord being $z = c$

$$+ \frac{1}{2} \times \frac{1}{3} \frac{c^3}{2^3} + \frac{1 \, . \, 3}{2 \, . \, 4} \times \frac{1}{5} \frac{c^5}{2^5} + \frac{1.3.5}{2.4.6} \times \frac{1}{7} \frac{c^7}{2^7} \text{ \&c.}$$

when c is the chord of $9^\circ\frac{2}{3}$ the second term will be $\frac{1}{10000}$ very nearly, and consequently the cycloidal arc, equal to the chord of the circle, will blend itself with circular arc.

The circular excess may therefore be taken in terms of the chord of the arc of semi-vibration, of the sine of one half this arc, and of its verse sine.

$$\frac{1}{16} c^2$$

$$\frac{1}{4} s^2$$

$$\frac{1}{8} v$$

which last corresponds with the expression given by Euler.

When a free or detached pendulum vibrates, the arc must continually diminish, and with it the circular excess. To ascertain the amount of this quantity, which may be termed the variable circular excess, from the incipient and final arcs, together with the elapsed time; it is obvious that the law governing the rate of decrement in the arcs must previously be known. Two causes contribute towards producing this diminution of the arc, resistance of the medium, in which the pendulum moves; and friction on its axis of suspension. These must be considered separately; and in doing so, it is perfectly obvious that the minute difference between cycloidical and circular vibrations in small arcs, cannot produce any sensible effect on the rate of decrement; so that whatever law is established in regard to the cycloid, it may, without error, be extended to the circle, where no change takes place, in the centre of oscillation, during the semi-vibration, when a ball of finite magnitude is used, as would be the case in a cycloid.

First, with respect to the resistance of the medium considered as the only retarding cause. This must, according to every theoretical principle, be taken to vary as the squares of the velocities. Then in passing through any small space $\dot{z}$, the diminution of velocity ($\dot{\varphi}$) will be proportionate to v^2 the square of the velocity, and to $\dot{t}$ the time, but

$\dot{t} = \frac{\dot{z}}{v} \therefore \dot{\varphi} = v^2 \times \frac{\dot{z}}{v} = v\dot{z}$ or to the space multiplied by the velocity of movement through it.

Now, as before in fig. 2d, the velocity at π will be $\frac{\overline{a^2 - x^2}^{\frac{1}{2}}}{\sqrt{2}}$

And consequently this multiplied by $-2\dot{x}$ will be $= -\dot{\varphi}$

By expanding $\overline{a^2 - x^2}^{\frac{1}{2}}$ and changing the signs

$$\dot{\varphi} = \sqrt{2} \times a \times \left(1 - \frac{1}{2}\,\frac{x^2}{a^2} - \frac{1}{8}\,\frac{x^4}{a^4} - \frac{3}{48}\,\frac{x^6}{a^6}\ \text{\&c.}\right) \times \dot{x} \text{ and}$$

$$\varphi = C + \sqrt{2}\,.\,a \times \left(x - \frac{1}{2}\,.\,\frac{1}{3}\,\frac{x^3}{a^2} - \frac{1}{8}\,.\,\frac{1}{5}\,\frac{x^5}{a^4} - \frac{3}{48}\,.\,\frac{1}{7}\,\frac{x^7}{a^6}\ \text{\&c.}\right)$$

When $x = a$ φ should be equal to nothing, but the equation then becomes $C + \sqrt{2}\,.\,(a^2 - \frac{1}{2}\,.\,\frac{1}{3}\,a^2 - \frac{1}{8}\,.\,\frac{1}{5}\,a^2$ &c.)

therefore $C = -\sqrt{2}\,(a^2 - \frac{1}{2}\,.\,\frac{1}{3}\,a^2 - \frac{1}{8}\,.\,\frac{1}{5}\,a^2$ &c.)

When $x = 0$ the variable terms vanish, and the equation becomes $\varphi = -\sqrt{2}\,(a^2 - \frac{1}{2}\,.\,\frac{1}{3}\,a^2 - \frac{1}{8}\,.\,\frac{1}{5}\,a^2$ &c.)

The diminution of velocity is therefore proportionate to the square of the arc. And if $v =$ the velocity due to any arc of descent a, the actual velocity, when it is performed, will be $v - a^2\,\dot{v}$. The ascent due to this velocity will be $v^2 - 2a^2 v\dot{v}$, but the arcs being as the square root of the ascent, the arc due to the velocity will be $v - a^2\,\dot{v}$; therefore the diminutions of the arcs are proportionate to the squares of their length.

To determine the amount of circular excess in arcs constantly diminishing from the effect of resistance, let a the larger of two small arcs of descent which in any portion of time, considered as unity, diminishes to b,

Let $x =$ any portion of that time,

$y =$ the arc of semivibration at that instant,

$m =$ a modulus then $\dot{x} = \frac{-m\dot{y}}{y^2}$ and $x = C + \frac{m}{y}$

When $x = 0$ and $y = a \therefore C = -\frac{m}{a}$ and $x = \frac{m}{y} - \frac{m}{a}$

And when $x = 1$ $y = b$, consequently $1 = \frac{m}{b} - \frac{m}{a}$ or $ab = am - bm$, whence $m = \frac{ab}{a-b}$ and $x = \frac{ab}{ay - by} - \frac{ab}{a^2 - ab}$

whence is derived

$$y = \frac{ab}{\overline{a-b} \times x + b}$$

And $\frac{1}{16} y^2$, or the circular excess, will be $\frac{1}{16} \frac{a^2b^2}{(\overline{a-b} \times x + b)^2}$ expressed in terms of x and of known quantities. Then will $\frac{1}{16} \frac{a^2b^2}{(\overline{a-b} \,.\, x + b)^2} \times \dot{x}$ represent the fluxion of the variable excess of which the fluent is

$$\frac{a^2b^2}{16} \times -\frac{1}{a - b} \times \frac{1}{\overline{a-b} \times x + b} + C$$

When $x = 0$, $C = \frac{a^2b}{16 \times \overline{a-b}}$

The whole fluent, therefore,

$$\frac{a^2b}{16 \times \overline{a-b}} - \frac{a^2b^2}{16 \times \overline{a-b}} \times \frac{1}{\overline{a-b} \times x + b}$$ when $x = 1$

The fluent becomes

$\frac{a^2b - ab^2}{16 \times \overline{a-b}} = \frac{ab}{16}$ and this quantity multiplied by the number of seconds observed between the two arcs of semi-vibration a and b, will give the whole circular excess in seconds.

In the next place, regarding friction as the sole retarding power which is known to act simply in proportion to the time, and without any reference to velocity.

It is obvious that while this is supposed to be extremely small in comparison with the force of gravity, resolved into the direction of motion at the commencement of the descent, and all increase of weight in the oscillating body arising from centrifugal force, is disregarded, as being insensible; that the retardation of velocity in isochronous vibrations must be equal.

If this general deduction, however, admits of doubt, it may be demonstrated in the following manner:

The velocity at π (Fig. 2d,) will be $\frac{\overline{a^2-x_2}^{\frac{1}{2}}}{\sqrt{2}}$ consequently the time of passing through $2\dot{x}$ will be $\frac{2 . \sqrt{2} . \dot{x}}{\overline{a^2-x_2}^{\frac{1}{2}}}$. Let the uniformly retarding power of the friction, as compared with the constant force of gravity be g, then will the fluxion of the retardation be $\frac{2 . \sqrt{2} . g . \dot{x}}{\overline{a_2-x^2}^{\frac{1}{2}}}$ the fluent of which is

$2 . \sqrt{2} . g \times$ Cir. Arc to radius unity and cos. $\frac{x}{a}$

When $x = a$

$= 2 . \sqrt{2} . g \times$ quadrantial Arc to radius unity, which is a constant quantity.

Since, then, the velocities are uniformly diminished, so will be the arc of ascent due to such velocities, from what has been already shewn: assuming therefore, as before, a, to be the incipient semi-arc of free vibration, and b equal to the final semi-arc, the time of passing from one to the other to be unity, x an elapsed portion of that time, and y the corresponding arc of semivibration with m a modulus,

$\dot{x} = -m\dot{y}$ the fluent $x = -my + c$, when $x=0$ $c=ma$

The whole fluent, therefore, $x=ma-my$, when $x=1$ $y=b$, consequently $1 = ma - mb$, or $m = \frac{1}{a-b}$ whence

$x = \frac{a}{a-b} - \frac{y}{a-b}$ and $y = a - a{-}b \,.\, x$, consequently, the fluxion of the variable circular excess $\frac{1}{16}(a - \overline{a-b}\,.\,x)^2 \times \dot{x}$ the fluent of which is $\frac{1}{16}\left(a^2x - a \times \overline{a-b}\,.\,x^2 + \frac{\overline{a-b}^2}{3}\,x^3\right)$ when $x = 1$ equal to $\frac{1}{16}\left(\frac{a^2+ab+b^2}{3}\right)$ which multiplied by the number of seconds observed between the arcs a and b, will give the whole circular excess in seconds.

And here it may be remarked that the expression $\frac{a^2 \times ab \times b^2}{3}$ corresponds, as it ought to do on the supposition, with that for measuring the frustum of a pyramid.

A formula involving both these causes would be extremely complicated if, indeed, the fluent could be assigned in finite terms. But it is probable that by carefully noticing the variable circular excess between two very small arcs, and between two others comparatively large, some estimate may be formed of the relative magnitudes of the retarding powers exerted by friction, and by the resisting medium, unless the former should really be found inappreciable in all practical cases.

A TABLE for correcting the Time, as shewn by a clock, having a brass weight, or ball, to its pendulum, for the variation of one inch in the height of the barometer.

ARGUMENTS.—The time elapsed since the last observation of the barometer.

And the preſent observed height $\sim$ 30 inches $\pm\frac{1}{2}$ the variation between the observations—

Additive, if the sum is Plus.

Subtractive, if it is Minus.

h	$\frac{1}{10}$	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{4}{10}$	$\frac{5}{10}$	$\frac{6}{10}$	$\frac{7}{10}$	$\frac{8}{10}$	$\frac{9}{10}$	s
1 . .	00	00	00	00	01	01	01	01	01	01
2 . .	00	00	01	01	01	01	01	01	01	02
3 . .	00	01	01	01	01	02	02	02	02	03
4 . .	00	01	01	01	02	02	02	03	03	03
5 . .	00	01	01	02	02	03	03	03	04	04
6 . .	01	01	02	02	03	03	04	04	05	05
7 . .	01	01	02	02	03	04	04	05	05	06
8 . .	01	01	02	03	03	04	05	05	06	07
9 . .	01	02	02	03	04	05	05	06	07	08
10 . .	01	02	03	03	04	05	06	07	08	08
11 . .	01	02	03	04	05	06	06	07	08	09
12 . .	01	02	03	04	05	06	07	08	09	10
13 . .	01	02	03	04	05	07	08	09	10	11
14 . .	01	02	04	05	06	07	08	09	10	12
15 . .	01	03	04	05	06	08	09	10	11	13
16 . .	01	03	04	05	07	08	09	11	12	13
17 . .	01	03	04	06	07	09	10	11	13	14
18 . .	02	03	05	06	08	09	11	12	14	15
19 . .	02	03	05	06	08	10	11	13	14	16
20 . .	02	03	05	07	08	10	12	13	16	17
21 . .	02	04	05	07	09	11	12	14	16	18
22 . .	02	04	06	07	09	11	13	15	17	18
23 . .	02	04	06	08	09	12	13	15	17	19
24 . .	02	04	06	08	10	12	14	16	18	20

ART. XIV. *Proceedings of the Royal Society.*

THE following papers have been read at the table of the Royal Society since our last Report:—

January 9, 1823.

Corrections applied to the great meridional arc, extending from latitude 8° 9′ 38.39″ N., to 18° 3′ 23.64″ N., to reduce it to the Parliamentary standard, by Lieutenant-Colonel William Lambton.

At this meeting John Henry Vivian, Esq. was elected into the Society.

January 16.

Some practical observations on the concentration and communication of magnetism, by Mr. J. H. Abraham.

January 23.

Observations on magnetism, by John Macdonald, A.M., F.R.S.

There was no meeting of the Society on Thursday, the 30th of January, it being the anniversary of the martyrdom of Charles I.

February 6.

Letter from Major-General Sir Thomas Brisbane, addressed to the President, enclosing a paper by Mr. Charles Rumker, on the summer solstice of 1822, observed at Paramatta.

Letter from Mr. Whidbey to John Barrow, Esq., accompanied with drawings of the caverns found in the limestone quarries of Oreston; also a description of the fossil bones found therein, by Mr. William Clift.

February 13.

A letter from Dr. Young to the President, announcing the re-discovery of Professor Encke's triennial comet, by Mr. Charles Rumker, the 2d of June last, at Paramatta.

At this meeting John Baron, M.D. of Gloucester, was elected into the Society.

February 20.

Experiments for ascertaining the velocity of sound, made at Madras, by John Goldingham, Esq.

Captain John Franklin, of the Royal Navy, was elected into the Society at this meeting.

February 27.

On the question as to the evolution of heat during the coagulation of blood, by Dr. Charles Scudamore.

On the double organs of generation of the lamprey, the conger eel, the common eel, and the barnacle, which impregnate themselves; and of the earth-worms, the individuals of which tribe mutually impregnate one another. By Sir Everard Home, Bart.

ART. XV. *Proceedings of the Horticultural Society.*

Tuesday, January 7, 1823.

A PAPER by the President, on the flat peach of China, was read. It contains some curious particulars as to the habits of this very remarkable plant, which was imported by the Society from China in 1820. It appears to possess a degree of excitability exceeding any that can be given, even temporarily, to any other variety of peach. In 1821, its blossoms unfolded in January in a peach-house, the lights of which were all off, and the fruit set freely, with the protection of a mat only. Last year it blossomed in November, before the lights of the house were put on; and on the 3d of January, when the paper was written, the peaches were as large as peas, with no more heat than would just exclude the frost. What is very remarkable in this plant is, that it retains its old leaves in full vigour until after the new are put forth.

Several collections of pears and apples were exhibited; among the vegetables shown, were remarkably fine specimens of an early variety of rhubarb, grown by Mr. William Buck, in the garden of the Hon. Greville Howard, at Elford near Lichfield. It is of a beautiful pink colour, which it retains when cooked.

Tuesday, January 21.

A paper by James Robert Gowen, Esq., was read, descriptive of a new beautiful hybrid amaryllis, raised by William Griffin, Esq., and which had flowered in the stove at Highclere.

A paper by David Powell, Esq., was read, communicated by Charles Holford, Esq., on an easy method of securing the scion to the stock in grafting.

Two papers, on the cultivation of the mushroom, were read, one by

James Warre, Esq., the other by Mr. William Hogan, gardener to Mr. Warre.

A paper, by Mr. Thomas Milne of Fulham, on the cultivation of the English cranberry (vaccinium oxycocus,) in *dry* beds, was read. Mr. Milne's success in managing this very desirable fruit, which has hitherto been considered incapable of cultivation, has been such as to leave no doubt that it will soon become an inhabitant of our gardens.

Various seeds and scions were distributed to the members present, and numerous specimens of fruits were exhibited.

Tuesday, February 4.

His Majesty the King of Bavaria was elected a Fellow of the Society.

The following papers were read:—

On the autumn and winter management of cauliflowers, so as to preserve them through the winter. By Mr. George Cockburn, gardener to William Stephen Poyntz, Esq.

On the cultivation and propagation of gardenia radicans. By Mr. Samuel Sawyer, gardener to Isaac Lyon Goldsmid, Esq.

On the management of fig-trees in the open air. By Mr. Samuel Sawyer.

Notes on the effects of frost upon glazing. By Joseph Sabine, Esq., F.R.S., &c., Secretary.

On forcing strawberries. By Mr. George Meredew, gardener to Charles Calvert, Esq.

Mr. Robert Clews, gardener to the Duke of Devonshire, at Chiswick-house, exhibited various sorts of grapes in a state of perfect freshness.

Many varieties of apples and pears were also shown, sent by different members.

Tuesday, February 18. The following papers were read:—

On a method of treating potatoes, so as to preserve them in a fresh state during the winter. By Mr. John Goss.

On a variety of brassica oleracea fimbriata, called Woburn perennial cabbage. By Mr. John Sinclair, gardener to his Grace the Duke of Bedford, at Woburn.

On the fertilization of the female blossoms of filberts. By the Rev. George Swayne. Mr. Swayne's talents, as a careful experimentalist in horticulture, are well known; and the present paper affords another proof of the advantages which are to be derived from a combination of philosophical inquiry with practical skill. Mr. Swayne suspected that the infertility of the filbert was occasioned by the deficiency of male blossoms; and it occurred to him, that by obtaining branches of the wild hazel, and suspending them over the filbert plants, he would compensate for that deficiency. This experiment he tried with complete success, and the paper gives an interesting detail of his mode of operating.

Tuesday, March 4.

A paper on the cultivation of melons in the open air, by John Williams, Esq., was read.

A communication by the Rev. John Bransby, was read, stating some useful particulars as to the best mode of cultivating the tetragonia expansa, or New Zealand spinach.

A paper by Mr. John Lindley, the Assistant-Secretary at the garden, was read, containing some particulars relative to the seedling varieties of amaryllis, which had been raised by the Hon. and Rev. William Herbert, and flowered in the garden of the society. Several of the varieties, in fine flower, were shewn at the meeting.

A large collection of fruits, preserved in spirits, were exhibited; they were brought home by Mr. George Don, a botanical collector in the service of the Society. They had been collected at St. Thomas's, Africa, Maranham, and Trinidad.

The silver medal of the Society was presented to Monsieur Charles Mathurin Villet, of the Cape of Good Hope, for his attention in sending a fine collection of bulbs and seeds to the garden of the society.

ART. XVI. ANALYSIS OF SCIENTIFIC BOOKS.

A Comparative Estimate of the Mineral and Mosaical Geologies. By GRANVILLE PENN, Esq. 8vo. Pp. 460. Ogle, Duncan & Co.

WE take shame to ourselves for having suffered this valuable book to remain so long unnoticed on our shelves, or only incidentally mentioned in some of our late reviews. At a period like the present, when many of the disciples of modern geology either boldly disclaim all belief in the Mosaical account of the creation, or consider it at best as a mere allegory—or when others, with a less daring but not less dangerous scepticism, admit, with Moses, the broad self-evident truth, that God did, at some time, and in some manner and form, call this world into being by his own immediate act, but deny that the time and mode are explicitly detailed in the sacred record he has bequeathed us;—when both allow, that since its first creation, it has obviously undergone a violent revolution, but contend that the history of the deluge is insufficient to account for it;—and when a third party, professing its belief in the Mosaical history, tampers with its details, or distorts them to any meaning that may best suit some favourite hypothesis, extending days into ages, multiplying revolutions, and, in short, giving the sacred text any interpretation rather than the literal and true one;—at such a period, we hail the appearance of the "Comparative Estimate," with unfeigned satisfaction. To relieve the mind of the anxious and sincere inquirer after truth "from perplexity; to disengage it from error concerning the important subject of which it treats;" and to demonstrate the essential connexion between moral and physical evidence, when we endeavour to explain the causes of the present state of the crust of the earth, by the sensible phenomena it presents to our inspection, are the great objects of this treatise. In inquiring how far this has been accomplished, we shall endeavour to give our readers an impartial account of its contents; in doing which we shall indulge very little in digression, and not at all in speculation—convinced, with our author, that what we cannot find within the limit of a true philosophical geology, "is not permitted to the sphere of our real knowledge. To *know* that we *cannot know* certain things, is in itself positive knowledge, and a knowledge of the most safe and valuable nature; and to abide by that cautionary knowledge, is infinitely more conducive to our advancement in truth, than to exchange it for any quality of conjecture or speculation." We shall hold our author's ground sacred, to be trodden by no foot but his own—

we shall abstain even from endeavouring to shew the relation of facts, discovered since his work appeared, with the sound geology he advocates. We shall leave the hyænas, in the cave of Kirkdale, to feast on elephants, and pick their teeth with rats-bones at their leisure; we shall not stop to ask, whether the gnawings on the larger bones are as evident to the natural eye as to the eye of the imagination, nor whether the proportion of Album Græcum to the hundreds of teeth and bones which, we are informed, were strewed over the mud at the bottom of the cave, from one end to the other, "like a dog-kennel," was such as is usually found in dog-kennels of the present day, or only what would necessarily be left after the decomposition of the more destructible matter of dead carcasses. It is not, however, that we conceive the explanation of the phenomena of the Yorkshire cave to be amongst those things which are not permitted to the sphere of our real knowledge, or that any serious difficulty attends their reconciliation to our author's geological interpretation of the sacred text; but in pure deference to him, we forbear to meddle with a subject which properly belongs only to himself. We shall, therefore, wait in patience for the second edition of the "Comparative Estimate," in which, we are confident, our expectations will not be disappointed.

The object of the work, as its title denotes, is to examine and decide between the mineral and the Mosaical geologies, as to their respective pretensions to guide us in our investigation of the modes by which, and the times in which, the several classes of mineral matter composing this earth received their sensible formations.

> The latter of these geologies is of very great antiquity, and rests its credit for the truth of the historical facts which it relates, upon a record pretending to *divine revelation*, and acknowledged as such by the uninterrupted assent of some of the best and wisest of mankind, for upwards of three thousand years. The former is of very recent origin, and can hardly be said to have existed in a state approaching to maturity for more than half a century. It does not indeed pretend to oppose any record to that of the other; but it aspires to establish a series of historical facts, by induction from chemical principles newly discovered, which, it affirms, disclose evidence of truth superior to any that is presented in the professedly historical document, and which must, therefore, qualify the credit which that document is entitled to receive.

It pretends that, by employing the method of analysis and induction from "observation, sound principles of physics, and the rules of an exact logic," introduced by the happy revolution effected by Bacon and Newton in the studies of the natural sciences, and by "adhering to the rules taught and practised by those great teachers, it is able to reason from the sensible phenomena of mineral matter, to the mode of its first formations and subsequent changes." The Mineral Geology (under which term our author includes the Wernerian and Huttonian, as well as all other geological systems not founded on the

Mosaical history) appeals, therefore, to the philosophy of Bacon and Newton in proof of its own validity; and since the merits of the two geologies can only be tried by applying both to some common and agreed test, the Mosaical consents to submit itself unconditionally to the same philosophy, and to leave to its verdict the ultimate decision, which is true, and which false—for so wholly contradictory are they to each other, "that whichever of them be true, the other must of necessity be absolutely and fundamentally false."

Before we proceed further, it is necessary to inform the reader, that whenever our author asserts that such a statement is made, or such a conclusion drawn by either of the contending parties, he invariably supports his assertion by reference to some writer of established authority, and, in most cases, quotes the passages referred to. Indeed nothing can be further from chicanery or subterfuge, than the manner in which he conducts his argument from beginning to end; and the work is not more remarkable for the closeness of its reasoning, and the *lucidus ordo* that prevails throughout, than it is for the spirit of upright honesty and manly candour which animates every page of it. He thus proceeds:

> The mineral geology concludes, from the crystalline phenomena of this earth, that it was *originally a confused mass of elemental principles, suspended in a vast dissolution, a chaotic ocean, or original chaotic fluid*; which, after an unassignable series of ages, *settled themselves* at last into the order and correspondence of parts which it now possesses, by a gradual process of precipitation and crystallization, according to certain laws of matter, which it denominates the laws of affinity of composition and aggregation, and that they thus formed successively, though remotely in time, 1. a chemical, 2. a mineral, and lastly, a geognostic, which is its present structure.

Is this conformable to Newton on the same subject?

> It seems probable to me, (said the wise, sober, and circumspect Newton,) that God in the beginning, formed matter in solid, massy, hard, impenetrable, moveable particles, of such sizes and figures, and with such other properties, and in such proportions to space, as most conduced to the end for which he formed them. All material things seem to have been composed of the hard and solid particles above-mentioned, variously associated in the first creation, by the counsels of an intelligent agent. For it became him who created them to set them in order, and if he did so, it is unphilosophical to seek for any other origin of this world, or to pretend that it might rise out of a chaos by the mere laws of nature; though, being once formed, it may continue by those laws for many ages *.

So much for the first result of the application of the test.

The mineral geology has stated further, that "during the long process of crystallization and precipitation, and before it attained to its present solidity, the earth *acquired* its peculiar figure (that of an oblate spheroid) by the operation of the physical laws which cause it to revolve on its axis." This Newton had observed to be the form of the planets; and reasoning on the fact, he discovered that the "rule of harmony and equilibrium" between the two antagonist powers of gravity and centrifugal force can only be found in that figure. Hence the mineral geology appeals to his philosophy in support of its assertion, and concludes, "since the earth has that spheroidal form which its motion of rotation ought to produce in a liquid mass, it follows, necessarily, that it must have been fluid."

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* Optics, L. iii. in fin.

It does not follow necessarily, nor at all, nor is any such consequence deducible from Newton's philosophy. Newton, with no other view than to illustrate his meaning, *supposed* an earth formed of an uniformly yielding substance, in order to shew that whilst at rest such a mass would be spherical, but that when made to revolve on its axis, it would assume a spheroidal form. But Newton constantly maintained "that God *at the beginning* formed *all* material things (and, therefore, this earth which is one of them) of such figures and properties as most conduced to the end for which he formed them," and consequently, for the reasons already given, "he formed the earth with the same figure which, it is manifest, he has given to the other planets. Moreover, unless the earth was actually flatter at the poles than at the equator, the waters of the ocean constantly rising towards the equator, must long since have deluged and overwhelmed the equatorial regions, and have deserted the polar, whereas the waters are now retained in equilibrium over all its surface." Thus its oblate spheroidal form is no proof of its original fluidity, though it is an incontestable one of that divine wisdom which fashioned it according to the strictest rule of "harmony and equilibrium" between those laws which he had ordained it should for ever after be obedient to, and which therefore "most conduces to the end for which he formed it." 'Thus, both from crystalline character and from the obtuseness of spherical figure, the mineral geology concludes to chaos; whereas from both of these Newton concluded to God.'

Our author proceeds to shew that this discordance between the conclusions of the mineral geology and those of Newton, arises from the analysis of the former being limited to mineral matter, whereas Newton's included all matter, of which mineral matter is only a part. The investigation of the *mode* of the first formation of mineral matter must be connected with the investigation of the mode of the first formation of all matter in the general, otherwise we assume a partial principle for a general, and setting out in error, must continue in it to the end. "Such a wonderful conformity in the planetary system," said Newton, "must be the effect of choice, and so must the uniformity in the bodies of animals; these and their instincts can be the effect of nothing else than the wisdom and skill of a powerful, ever-living agent."

With common sense and Newton, all first formations are *creations*, and by that term he denoted them. Were it otherwise, there would be formations before first formations, which is absurd. Deluc would not use the term *created*, because, said he, "in physics, I ought not to employ expressions which are not thoroughly understood between men." Our author reprobates his conduct and his argument with just severity. "Was he aware," says Mr. Penn, "that in excluding the *word*, he at the same time excluded the *idea* associated with that word; and, together with the *idea*, the principle involved in that idea—the exclusion of which is the very parent cause of all materialism and all atheism?"

It was the all-sufficiency ascribed by the mineral geology to physical impressions, or what it denominates phenomena, to determine the great question of the mode of the first formation of mineral substances, that induced it to check its analytical progress, short of the end to which it ought to have pursued it. Our author, therefore, proceeds to shew how *insufficient* phenomena alone are to determine that question.

> If a bone of the *first created man* now remained, and were mingled with other bones, pertaining to a *generated* race; and if it were to be submitted to the inspection and examination of an anatomist, what opinion and judgment would its *sensible phenomena* suggest, respecting the mode of its first formation, and what would be his conclusion? If he were unapprized of its true origin, his mind would *see nothing* in its *sensible phenomena*, but the laws of its ossification; just as the mineral geology "sees nothing in the details of the formation of minerals, but precipitations, crystallizations, and dissolutions." He would therefore naturally pronounce of this bone, as of all other bones, that "its fibres were originally soft," until, in the shelter of the maternal womb, it acquired "the hardness of a cartilage, and then of bone;" that this effect "was not produced at once, or in a very short time," but by degrees; "that after birth, it increased in hardness, by the continual addition of ossifying matter, until it ceased to grow at all."
>
> *Physically true* as this reasoning would appear, it would nevertheless be *morally* and *really false*; because it concluded from *mere sensible phenomena*, to the *certainty of a fact* which could not be established by the evidence of sensible phenomena *alone*; namely, the mode of the *first formation of the substance of created bone.*
>
> From hence we obtain a second principle, with respect to such first formations by creation, that their sensible phenomena alone cannot determine the *mode* of their formation, since the *real mode* was in *direct contradiction* to the sensible indications of those phenomena.

The same ingenious argument is then applied to vegetable first formations, and the just inference deduced from both—that, from *phenomena alone*, physics can determine nothing "concerning the mode of the first formations of the first individuals composing either the *animal* or *vegetable* kingdoms of matter."

Nor are they "a whit more competent to dogmatize concerning the mode of first formations, from the evidence of phenomena alone, in the *mineral* kingdom, or to infer that it was more gradual, or slower, than those of the other two. For," continuing the comparison, and transferring it to created mineral matter, 'the sensible phenomena which suggest crystallization to the

Wernerian, or vitrification to the Huttonian, in examining a fragment of *primitive rock*, are exactly of the same authority, but not of a particle more, with that which would have suggested ossification and lignification to the anatomist and naturalist, who should unknowingly have inspected or analyzed *created bone* or *created wood*"—and all would be equally in error, in concluding them to have been respectively formed by the modes of crystallization, ossification, and lignification. "The mineralogist can no more discover the *mode* of the formation of primitive rock by the laws of general chemistry"—"than the anatomist can discover the *mode* of the formation of *created* bone, by the laws of generation and accretion."

Concluding, then, with Newton, that "God at the beginning formed *all* material things" of such "figures and properties as most conduced to the end for which he formed them, we perceive that there must have been a first-formed created man, as certainly as there has since been a succession of generated men; and that it is most consistent with the notion of an intelligent agent, and therefore most philosophical, to suppose that he created that first man with the perfection of mind and body which most conduced to the end for which he formed him"—and the same argument is equally applicable to all other first created animals, and every first created individual of the vegetable kingdom. As, therefore, in two parts out of three of the tripartite system of matter, we have ample ground to conclude, "That the first formations must have been produced in their full perfection, *perfect bone* and *perfect wood*," we must infer, from every principle of sound analogy, that in the third part, "where the first formations were as essential to the structure of the globe, as in the two former to the structure of their respective systems, the first formations were likewise produced in their full perfection, *perfect rock*—and we have seen that *sensible phenomena* can have no authority whatever in this question."

The fatuity of the analogies by which the mineral geology attempts to support its darling chaos, and the absurdity of inferring, from the slow progress of generated beings to maturity, the slow progress of the earth from a state of confusion to its present form, is next forcibly demonstrated, and Deluc's trash about mountains and pyramids ridiculed as it deserves to be.

Equally absurd is the attempt to find secondary causes for first-formed, created things. Of this class are the speculations concerning the agents by which the mineral geology supposes primitive rocks to have been held in solution. To prove the legitimate relation between cause and effect, either the cause must be known in the course of actual operation, or the effect in the course of actual production; and who ever knew a granite rock in course of actual production, or a menstruum exhibiting a cause capable of producing it? Secondary causes can only effect secondary productions. Created bone and wood were not produced by secondary causes—" yet we know that there are secondary causes which produce bone and wood, but we know of no secondary cause that produces granite—and the reason appears to be obvious; for the animal creation (from the perishable nature of the individuals that compose it) was to subsist by succession to the first-formed individuals, and therefore laws for securing that succession were necessary: but the mineral creation was to subsist permanently in its first-formed individuals, therefore no laws for their multiplication were necessary. And from this consideration alone accrues a very powerful moral evidence, that the first mineral formations which are still permanent, were formed by no other mode than that" (viz. creation) " which formed the *first animals*, which have been succeeded by generation."

The crystalline texture and hardness of granite rocks, whence they derive their solidity and durability; their immense height, to which is owing the accumulation of supplies for the rivers which irrigate the globe, together with their lengthened and inclined forms to determine the direction of those rivers, are so many proofs of unchangeable arrangement which adapts them "to the end for which they were formed"—and "how is it possible," exclaims our author, " to contemplate all this, without rendering immediately to God the things which are God's?"

Having shewn, in the first part of the work, that the chaotic principle of the mineral geology is incapable of standing the test of the reformed philosophy of Newton, our author proceeds, in the second part, to examine by the same test the pretensions of the Mosaical Geology to explain the mode of the first formation and the revolutions of this earth. From the philosophy of Newton we attain the highest probabilities in regard to this subject, and the Mosaical geology professes to add the consummation of absolute certainty. But certainty as to past events can only be derived from competent and positive history. Now, the history which professes to account for the mode of the first formations and revolutions of the earth, is that " 'Revealed History' which was imparted to man by God, (the only possible *voucher* for the facts of creation), through the ministry of Moses;" the authority of which record the judgments of Bacon and Newton unequivocally and entirely acknowledged, and the former grounded the foundation of his new philosophy on its statements.

This sacred and inestimable record, which was revealed to mankind above 3000 years ago, unfolds a detailed recital of the *sensible mode* by which God "formed and set in order" the entire system of this terrestrial globe; and likewise the history of a great universal revolution, which he caused it to sustain by the operation of water, 1656 years after he had created it.—This record comprises the Mosaical Geology.

Our author then proceeds, in the first place, to shew, that the interpretation of the Hebrew text in the first chapter of Genesis, as it stands in our Bible, is not absolutely correct, and to suggest the alterations which seem to him to be necessary, and which he supports with great learning and critical acumen. He adopts and defends the canons of interpretation laid down by Rosenmuller, namely, " That the style of the first chapter, as of the whole book of Genesis, is strictly *historical*, and that it betrays no vestige whatever of allegorical or figurative description." That " since this history was adapted to the comprehension of the commonest capacity, Moses speaks according to *optical*, not physical truth—that is, he describes the effects of creation *optically*, or as they would have appeared to the eye, without any assignment of physical causes."

A circumstantial inquiry into the events of the six days of creation, with occasional criticisms on the true interpretation of the original Hebrew, occupies the remainder of the second part. It would be impossible, within the limits of a review, to follow the author through all the details of this important division of his work. We must therefore refer our readers to the original for the several minutiæ, and confine ourselves to the general outline, with such occasional quotations from the text, as the importance of the subject, or justice to our author, may seem to require.

" At the beginning," says Newton, " and in one moment of time," says Bacon, the earth was created, entire and complete, as to its form and texture, though enveloped with a marine fluid, resting on and flowing over every part of its surface, which formed for a very short time the bed of an universal sea. The solid body was concealed by the cloak of waters, and total darkness encompassed that cloak; God then commanded the existence of light, and divided the light from the darkness— " that is, he established and gave first operation to the laws of proportion and succession between the measures of the two, and having given origin and action to those laws, they accomplished in their due course the first day.

The apparent confusion between the command, " *Let there be light*," delivered on the first day of creation, and the record that God made two great lights, on the fourth day, which has been a stumbling-block to many eminent writers, is thus ingeniously cleared up by our author.

The light of which Moses speaks in the first day, " proceeded from the same *solar fountain* of light" that has always illuminated this world, but " ignorance on the one hand, and system and hypothesis on the other, have variously contrived to perplex or pervert this simple recital." The late Sir William Herschel discovered that the body of the sun is an opaque substance, and that its light and heat proceed from a luminous atmosphere attached to its surface. "So that the creation of the sun as a part of 'the host of heaven,' does not necessarily imply the creation of light, and conversely, the creation of light does not necessarily imply the creation of the *body* of the sun. In the first creation of 'the heaven and the earth,' therefore, not the planetary orbs only, but the solar orb itself, was created in darkness, awaiting that light which by one simple divine operation was to be communicated at once to all. When, then, the almighty word, in commanding light, commanded the first illumination of the solar atmosphere, its new light was immediately caught and reflected throughout space, by all the members of the planetary system. And well may we imagine, that, in that first sudden and magnificent illumination of the universe, 'The morning stars sang together, and the sons of God shouted for joy!'"

The body of the sun itself, however, or rather its luminous atmosphere, was still concealed from the earth by the waters on its surface, and the exhalations which the sun's heat raised from them. It was not till the fourth day, that the cause of light was to be visibly revealed to the earth. But its *effects*, and the alternation of light and darkness, subsisted from the first day, when "both the solar fountain of light was opened in the heavens, and the earth received its first impulse of rotation on its axis, and in its orbit:" and consequently, "*time*, which only exists in reference to that revolution, began with the creation of the globe, and the commencement of its revolution in darkness; and the creation of light succeeded at that proportion of distance in time, which was thenceforth to constitute the perpetual diurnal divisions of the two."

The philosophy of Bacon and Newton is in perfect unison with the sound learning and criticism of Rosenmuller, and concurs with him in concluding, that the days of creation were not, as the chaos of the mineral geology requires, indefinite measures of time, but *natural days*—beginning from one evening, and ending with the next; and he equally coincides with those illustrious men in reprobating, in the strongest terms, the preposterous inference of a chaos from the language of Moses.

The division of "the waters from the waters," by the firmament, is explained to mean the separation of the watery vapours from the waters covering the earth, by the creation and interposition of the aërial atmosphere; but this vapour, in the form of congregated clouds, still prevented the sun itself from being visible.

The mode of the "*gathering together of the waters* into one place," on the third day, forms a remarkable feature in our author's exposition of the sacred text. This he considers to have been effected by a violent disruption and depression of the solid parts, which were to be deepened, in order to form the bed of the sea, into which the waters were now to be collected. "The solid 'framework or skeleton of the globe' was therefore burst, fractured, and subverted, in all those places where depression was to produce the profundity; and it carried down with it, in apparent confusion, vast and extensive portions of the materials which had been regularly deposited or compacted upon it, leaving other portions partially dislocated and variously distorted from their primitive positions. So that the order of the materials of the globe, which, in the reserved, unaltered, and exposed portion, retained their first positions and arrangement, was broken, displaced, and apparently confounded in the other portion, which was to receive within it the accumulated waters."

On the same day, the newly-exposed portion was, by the immediate creative act of God, covered with the maturity of vegetation—"the herb yielding seed, and the tree yielding fruit," each after its kind, in complete and instantaneous perfection. On the fourth day, the clouds were dispelled and the sun became visible in the heavens, "in the full manifestation of its effulgence." The moon also became visible on this day, that is, on the third evening of the earth's revolution, according to common computation, which answers to the fourth evening of the Mosaical day, or Nycthemeron. "Thus the Creator reserved the exposure of his heavenly calendar, for the day when the planet which, by his own laws, was to rule the night, had acquired by those same laws the position which *first* enabled it to display its domination." Whence we infer, that at the moment of their creation on the first day, the sun and moon "were in that particular relation to the earth, which astronomy calls inferior conjunction, and that in its diurnal revolution they first acquired, by their separation, that relative aspect which qualified them to be manifested together, as the two great indices of annual and menstrual time, but for which manifestation, *both* would not have been prepared on an earlier day." Thus the first day of creation was the first day of the first solar year, and the first day of the first lunar month; and, as we learn afterwards, by the sanctification of the seventh day, the first day of the first week; and "it is sufficiently manifest, from the concurring authorities of learning and philosophy, that the solar light which, upon the fourth day of creation, was transmitted *immediately* and *optically* from the solar orb, was the same light that, during the three preceding days, had been transmitted through a nebulous medium, interposed between it and the earth."

But we must forbear to travel thus, step by step, with our uthor; and, painful as the exertion is to quit even for a short time so delightful a companion, we must leave him to comment alone on the great events which yet remained to be accomplished in the fifth and sixth days, namely, the creation of the animal kingdom, "closing full in man," each individual in full maturity and perfection, by the immediate and instantaneous act of God; and to shew, in the concluding chapter of this part, how positively the philosophy of Bacon and Newton decides the first great question, the mode of first formations, in favour of the Mosaical geology. One important fact, however, we must remind the reader to keep in his recollection, viz., the structure of the bed of that ocean, on whose ruptured slimy bottom were now deposited, in abundance, marine matter of every kind, vegetable and animal, and which continued to increase, in a multiple ratio, during a period of more than sixteen centuries.

Our author, in the third part, proceeds to examine the second great question, the mode of the universal changes or revolutions which the mineral substance of the earth has undergone since the creation, and whether the evidences of revolution which it reveals, correspond with the statements of the sacred record, and are sufficiently accounted for by it; or "whether the mineral geology has found evidences of revolution not reducible to those stated in the record."

God having determined, in consequence of the wickedness of the human race, to *destroy both it and the earth*, suspended for a time the order of things which he had established, and again assumed an immediate operation in the works of his terrestial creation; "All the fountains of the great deep were broken up, and the windows of heaven were opened." But, after the deluge had accomplished its work of destruction, and the Almighty was pleased to withdraw the waters a second time from the surface of the earth, "what was that *second* earth upon which the ark was brought to rest, and whence did it derive its origin?"

> We cannot fail to perceive that a repetition of the same process which produced the *former* earth was alone requisite to bring to light *another* earth to replace it. We have already seen that a violent disruption and subsidence of the solid surface of *one portion* of the subaqueous globe produced at first a bed to receive the diffusive waters; and that these waters drawn into that bed from off the *other portion* of the same globe, left it exposed and fitted for the reception of vegetation, and for the habitation of man. That *exposed portion* was now in its turn to sink and disappear. By a similar disruption and subsidence of its surface, which should depress it below the level of the first depressed part or basin of the sea, the waters flowing into a *still lower level*, would leave their basin empty, exposed and dry, and thus by a *similar separation* render it in its turn a habitable earth:—thus that first depressed part or basin of the former sea is our actual present earth.

This idea, we believe, is peculiar to our author, who, with great depth of learning and argument, contends that the destruction of the former earth was not temporary and confined to the surface, but final and entire. The most strenuous advocate for the mineral geology cannot deny that the conclusion is ingenious. It removes many difficulties which any other view of the subject has to contend with; it does away with the necessity of those repeated revolutions, which, on no ground but that it cannot do without them, the mineral geology is continually having recourse to, and it refers similar effects to similar causes. Throughout his whole argument our author connects physical causes and events with the moral effects they were destined to produce; and, it is for want of this rational association of the two, that the mineral geology, perplexed with difficulties of its own creating, fails to draw correct inferences from either. It sees, in the beginning and the end, nothing but physical phenomena; it endeavours to explain them by reference to physical causes alone, according to its limited knowledge of those causes; it finds itself incapable of doing so, without assumptions irreconcilable with and in direct opposition to the Mosaical record, and therefore it concludes that record to be false, or misinterprets and makes it bend in every particular to rules drawn from its own preconceived and chimerical opinions.

The time allotted to this supernatural revolution was twelve months. At the moment when, by the subsidence of the old earth, the waters began to flow into their new bed, God grounded the ark on the summit of Mount Ararat: in seventy-three days after this event, the tops of the mountains appeared; and in sixty days more, the waters were entirely drained off from the surface of the earth. The security of the ark demanded this gradual transfer of the mass of waters, for, had the former continents sunk at once, the rush of the waters to fill the gulf must have hurried the ark into the tremendous vortex—but it is represented as riding securely on the surface of the universal ocean. "The ark *went* upon the surface of the waters."

That the sea once covered the whole earth, and that its surface has undergone great destruction and depressions, and a violent revolution since its first formation, is acknowledged by both geologies, but the Mosaical admits only two revolutions, whilst the mineral affirms them to have been numerous.

Our author then proceeds to shew that the general phenomena of the earth may be satisfactorily referred either, 1. to the creation; 2. the first revolution; 3. the long interval that succeeded it, during which the sea remained in its primitive basin; or 4. to the second revolution. To the first cause belong the sensible characters and diversities of all primitive rocks and soils; to the second, those of their dislocation, fracture, and dispersion; to the third, the water-worn appearance of the larger and smaller fragments of rocks and stones, and the moulding of the loose soil over the solid substrata, as well as the vast accumulations of marine substances. Lastly, to the second revolution, the excavation of valleys in secondary soils; the heaping up of marine mineral masses; the secondary rocks, and the confused mixture of the organic terrestial fragments, once a part of the furniture of the earth that perished, are as evidently to be referred.

Of the natural agencies employed by the Almighty in the two great revolutions, our author supposes earthquakes and volcanoes to have been the most probable; and it is well known that there is an intimate connexion between them. Some geologists, however, reasoning from the limited effects of existing volcanoes, have denied their sufficiency; but, "it is one thing to compute the power of a volcano, and another thing to compute the power of volcanic action;—the possible effects of volcanic power, rendered general within the globe, and acting simultaneously against its solid crusts, without a regular vent to determine its issue, cannot be measured by the effects of an individual volcano acting on one point, at which it has found a channel to discharge its violence." The presence of water too in great quantities in volcanic phenomena, which, from the actual situation of existing volcanoes, 'on islands or on coasts not far from the sea,' we may conclude 'is a condition essential to their existence;' and the evidence of their having prevailed 'anterior to the formation of valleys,' "that is, previous to the depression of the earth's surface," are circumstances which increase the probability, that their powers were called into action in the first revolution. For, in the first place, at that period water was in immediate contact with the entire surface of the earth, and its admission, "at one and the same moment, beneath a considerable extent of it, was able by the new laws of volcanic action, directed by their author, to cause at one and the same moment an equally extensive disruption, and consequent depression of that surface." In the second place, "the immense fusions of basalt," as witnessed at the Giants' Causeway, the Island of Staffa, &c. &c., and which the mineral geology considers as belonging 'to the most ancient epocha,' "demonstrate a remote period of volcanic effort in the interior of the earth, totally different in circumstance from the ordinary phenomena of conical volcanoes," (those now active,) "and of which we have no experience whatever except in those effects." Thus our author contends, that the unequivocal character of igneous fusion which pervades the great basaltic districts, is perfectly consistent with the sacred record; and, "if we superadd to the indefinite extent of volcanic power, the ordination and direction of its agency to a particular purpose by its Divine Author, we shall at once perceive that it was an instrument, calculated by its laws to operate to the fullest extent of the effects which we here ascribe to them."

The remains of animals of all species and climates are found in vast abundance in the interior of the earth, and in situations far remote from their natural localities, so that exuviæ of the inhabitants of the torrid zone are often met with in the most northerly latitudes, and *vice versâ*. The mineral geology argues, therefore, that the animals to which these exuviæ belonged must have died, and consequently have lived in those latitudes where they are found; and that they could not have done so unless a revolution had taken place, either in the nature of those animals, or in the climates of the earth.

But the mere presence of their fossil exuviæ in such discordant situations is no proof that they either died or lived there. We know that the animals to which they belong existed on the former earth—that they were destroyed with it, and indiscriminately absorbed into the mass of waters, by which their destruction was effected. " If, then, it was physically possible that they should have been transported by those waters from the surface of the former earth into the bed of the former sea, and if that bed is now become our habitable earth, it was highly probable that we should discover such remnants of them as have not entirely mouldered away; and it will be much more philosophical to resort to that *possible* cause, than to violate by our conjectures the laws established either for the nature of animals, or for the climate of the globe."

But, on this supposition, the direction in which the waters have transported those exuviæ, seems to be diametrically opposite to their current; for, if the former continents existed in those tracts now covered by the Atlantic and Pacific Oceans, when they sunk into the abyss, the waters must have rushed from north to south, and how in that case, could the bones of the elephant or rhinoceros have been found in Siberia? " How could the sea, in moving from its bed, carry backwards and deposit within its bed the spoils that it absorbed from the continents which it had moved forwards to submerge?" The subsidence of the old continents was *gradual*—the limits or coasts which circumscribed the sea receded gradually during those subsidences—" but its violence, continually discharged against succeeding limits," produced the common effect of re-action and reflux of its waters, and this continued till the subsidence was completed; and thus retiring currents were formed, " retrograding as the flux advanced."

Such refluxes are known at the present day, between the continents of Africa and America, " and the waters of the South Sea, stopped by the continent of Asia, fall back naturally to the coasts of Chili, Peru, and Mexico*;" many other similar instances might be adduced.

Let us then suppose (what must have been the case) all the woods and forests of the former earth, of every latitude, uprooted, entangled together, and floating upon the bosom of the ocean; let us further suppose all the races of animals, of all climates, crowded confusedly in close contact, and in numberless masses, implicated in those floating forests, and buoyant upon the face of the waters, and operated upon by the impulsory powers of retiring currents, tides, and winds. It is impossible to deny, that such immense conjoined masses, presenting vast surfaces to the winds and retreating waters, would be driven before them to very great distances before they would all be submerged. If the continents from which they came were south of the sea bed, and if the sea flowed to the southward, they would then be transported in a northerly direction, just as the waters of the equatorial current, which fall against a western land, retrograde to an eastern sea.——Thus the spoils, successively gathered from the old continents, would have been driven over the northern parts of the primitive sea; would have been sunk upon different parts of its bed, and buried in its soils. And if a great moral end was capable of being effected by the operation, a fact which the present argument renders indisputable, the direction of these amazing monuments to their actual stations, by the instrumentality of the natural agent, was in every respect consistent with his power and intelligence who afterwards "caused a wind to pass over the earth, that the waters might be assuaged."

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* De la Lande. Flux et Reflux de la Mer. Tom. iv. p. 305

To prove that the distance between the old equatorial and present northern continents is not greater than might well have been traversed by those immense floating masses, our author mentions the fact of a vessel, almost under bare-poles, having come from Halifax to Spithead, a distance of three thousand miles, in thirteen days. The space from the equator to Tobolsk, in Siberia, is four thousand miles, and the mouth of the Lena is nine hundred miles farther.

The substances thus transported must necessarily have been imbedded in the yielding mud, in which they would ultimately sink,—some less, others more deeply, according to the peculiar circumstances arising from local causes; and as the transport was by water, and the bed that received them soft, they would be uninjured by trituration or fracture, and the bones of the several animals so deposited would be found, as they frequently are found, perfect and entire. But it has been objected that whole skeletons have not been found, and, *therefore*, they could not have been transported; but *wherever* the animals died, they must have died with their skeletons entire; and if parts only are found, the rest must have mouldered away,—and what difference could there have been, in this respect, whether they had died where they were found, or had been transported thither, and there deposited? Cuvier's argument (for it is he who advances it) makes rather against, than for the end to which he adduces it.

But facts also are against him, for the entire skeleton of an elephant has been found at Tonna, in Thuringia, another at the mouth of the Lena, and one of a rhinoceros in the banks of the Vilhoui. Thus we can account rationally for the discovery of the confused fragments of animals of all climates in the strata of our earth, and see how the bodies of elephants, rhinoceroses, &c., may have been transported from the torrid zone to the north of Europe, and imbedded at the various depths at which they are now found in England or Siberia, without requiring any change either in the natures of the species, or in the climates of the earth.

As to the multitudinous masses of bone found in caverns in Germany, Hungary, and elsewhere, our author very rationally, we think, concludes them to have been carried into those cavities, (which must have existed then as well as now, in the rocky bottom over which the animals were transported,) by the action of the water continually entering into and returning from them; for the returning water would not "have equal power upon the bodies with the entering water," and consequently would leave the bodies behind. "So that when the soil was not sufficiently soft to receive them, they would be driven forward and finally urged into the inmost recesses of the caverns, where they would afterwards be found in confused multitudinous and exposed masses, with all the circumstances which they now exhibit. And, because they would have been fixedly lodged before their skeletons were stripped of their integuments, and because the sea presently abandoned them, no appearance of *trituration* would be discoverable in the bones."

The whole human race, with the exception of a single family, is stated by the sacred record to have perished with the brute creation. Why then have not human bones been found in a fossil state, as well as those of elephants and other animals?

The mineral geology has suggested the answer.

> The place which man then inhabited may have sunk into the abyss, and the bones of that destroyed race may yet remain buried under the bottom of some actual sea.

The brute creation, without reflection and forethought, congregate together by instinct when alarmed, and await in trepidation the unknown evil. These, therefore, by the sudden subsidencies of the land on the spots where they chanced to be assembled, would have been surprised by the successive inundations, and carried away by the reflux of their waters. But the human race seeing the threatened danger coming on them, would retreat from the flood, gradually advancing on all sides, and draw more and more towards the centre of the continually diminishing circle, until, assembled in a multitudinous mass on the last remaining portion of dry land, they would on its subsidence be absorbed by the vortex occasioned by the conflux of the two seas meeting from the opposite hemispheres, and thus be carried down with violence into the depths of the new sea; "where their exuviæ must remain for ever uninvestigable by man." Moral considerations strengthen the probability that this was the course of that tremendous event, for the sufferings of the condemned and hardened race were thus protracted by their endeavours to escape from the catastrophe, till they had worked their destined effects.

A similar moral reflection will furnish us with a sufficient reason why the exuviæ of animals are occasionally met with, whose species no longer exist on the earth. Physical science unconnected with moral, cannot solve the difficulty, nor can it be expounded but by reference to the power and will of God; who, for reasons known only to the counsels of his divine wisdom, was pleased, when he communicated to Noah the species he designed to preserve "to keep seed alive upon the earth," to except some from that preservation.

Further on, our author mentions the singular fact, that the Arabian camel, (that with one hunch,) is not found wild in any part of the earth, existing only as the property of man, and deduces an ingenious inference from it, in opposition to an assumption of the mineral geology "that the revolution which destroyed the animal races of which we discover the fossil exuviæ, was different from that which established the progenitors of the human race in Asia." The circumstance can only be rationally accounted for by considering those animals as the descendants of the pair preserved in the ark, as all the present human race are the descendants of Noah, and, that from their great utility, none have ever since been suffered to escape from the dominion of man.

> The domesticity of the entire race of this peculiar species of camel, is therefore a living and perpetual evidence both of the revolution in which the whole animal creation perished, excepting a reserved few, and of that also in which the human race was first established on the continent of Asia.
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> Because animal and vegetable relics are found buried in the midst of soils, which are too confidently pronounced the most ancient secondary strata, and because land animals are found under heaps of marine productions, Cuvier at once assumes that the various positions of these relics constitute evidences of as many different revolutions.

They are, however, easily explained from the data of the Mosaical geology. After the imbedding of the innumerable land animals in the sands or slimy bottom of the primitive sea, violent and particular agitations within its basin may have dislodged and put in motion, especially in the latter stages of its draining, enormous masses of its loose soil, and have driven them, loaded with marine substances, upon the beds in which the terrestial animals had previously sunk; and repetitions of such events, which may and must have occurred during that disorderly crisis, would produce various alternations of such depositions, "diversified by different circumstances, and reducible to no rule of regularity and order." As to the fresh-water shells alleged to be found in some of these accumulations, a pertinent doubt is suggested by Mr. Greenough, whether the distinction between them and marine shells be so certainly ascertained as to allow of a conclusive argument founded upon that distinction.

Our author argues very forcibly on the impossibility that unconfined waters, diffused originally over a compact, extended, and nearly horizontal surface, should have formed valleys, or channelled out the beds of the rivers in which they now flow. There is no reason for supposing the Rhine and the Euphrates to be deeper or wider now than they were in the days of Cæsar and Cyrus; but if their waters had originally formed their own beds, since the action is continually going on, they ought to be continually increasing in width and depth. Valleys and mountains are obviously co-ordinate and correlative—"a mountain signifies nothing but an elevation above a valley, and a valley nothing but a depression below a mountain," and the cause of these differences of elevation has been already examined. "The varied system of valleys, and their intimate and direct relations both to mountains and rivers," is referable only to the divine wisdom which ordained, and gave to the mountains the very forms essentially necessary for "separating the beds of those rivers from one another; and serving moreover, by means of their eternal snows, as reservoirs for feeding the springs." The general system of rivers is to the earth what the vascular circulating system is to the animal and vegetable structure, the means by which the necessary fluids are distributed from one extremity to the other, and rivers like blood-vessels, are "so skilfully and equally distributed over the whole surface, so artfully diverted in many places from the nearest seas, and conducted through extensive inland regions," that they incontestably argue supreme intelligence in their designer.

On the formation of coal our author touches with the judicious caution which the obscurity of the subject demands. He concludes with Mr. Hatchett, to the probability of its vegetable origin; and from the failure of that celebrated chemist to produce bituminous coal, in his experiments on vegetable substances of land growth, and for other reasons, suggests that the beds of natural coal "were perhaps immense accumulations of fuci, &c., loaded with the various animal substances which shelter among them, and which were overwhelmed by vast aggregations of the loose soil of the sea, in the course of its retreat, and were left for decomposition by the chemical action of the marine fluid which they contained, and with which the enclosing and compressing soils were saturated *."

In the remaining portion of the work, our author ascribes the covering of the new earth with vegetation after the second revolution, to a fresh and immediate act of God; and infers, from the olive-leaf brought by the dove to Noah, that it was created in full and perfect maturity. He supposes it probable, also, that new animal species were at the same time created, to supply the place of those which it was the will of God to destroy

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* "There is every reason to believe, that the agent employed by nature in the formation of coal and bitumen, has been either muriatic or sulphuric acid."—HATCHETT, *Phil. Trans.* 1806, p. 141.—R.

utterly by the deluge. He shews by a learned argument, that the description of the rivers in the garden of Eden, (Gen. ii. 11—14,) is a marginal gloss in a transcript of the original history, which in time became incorporated with the text; and, consequently, that no inference, as to the identity of the former and the present habitable earth, can be drawn from that description. He then concludes, from the general result of the preceding inquiry, that the numerous revolutions assumed by the mineral geology "are the offspring of defective investigation and unregulated fancy," and are all reducible to those two only which are recorded in the Mosaical history; and that in the second question, "relative to the changes which this globe has undergone since its first formation, and to the mode by which those changes were effected, the Mosaical geology has maintained the superiority over the mineral, which it established in the first question relative to the mode by which that first formation was produced." A code of general principles, "which may at all times guide our view in contemplating the phenomena apparent in the globe, and secure us against the fascination of unsubstantial theories," followed by some valuable general reflections, closes the work.

We have thus given a pretty circumstantial account of this very interesting volume. The length of our review may perhaps seem to bear a somewhat too large proportion to the size of the book; but its value is not to be estimated by the number of its pages, and we could not, in justice to our author, condense his matter into a smaller compass. Indeed, so pregnant is it in argument, that nothing but a careful perusal of the work itself can give a perfect idea of its merit. The subject is investigated with logical precision, from the commencement to the conclusion. Nothing important is omitted or slurred over, that can fairly be adduced on either side of the question—all is candidly discussed, and the merit of every statement critically examined. If there be any thing in the work that we think might be improved, it is, that sometimes, though rarely, there is a little unnecessary amplification and repetition; and in one instance we do not very clearly understand the author's meaning. We allude to the part (not noticed in the body of our review) relating to the hebdomadal computation of time. We do not see what exact portions of time he would comprehend in his month and year, nor how those portions are to be defined. We wish he had been rather more explicit on this head; and that he had given us the result of Frank's attempt to construct a true fundamental chronology, founded on the golden period of the jubilee, which he alludes to.

The principal features of the work appear to us to be, the inference the author deduces from the sacred record, of two distinct revolutions, or periods of destruction, of the surface of the earth: his mode of reconciling the accounts of the creation of light on the first day, and the sun's visible appearance on the fourth: the reasons why fossil remains of some animals are found in climates uncongenial to their natures, and of others whose species are utterly extinct; as well as why fossil human bones have never been found at all. The ingenuity, too, with which he proves the incompetence of mere physical phenomena to decide on the mode of first formations, is extremely striking, as well as many other parts of the work, which we have not room to enumerate. Our author's claims to a high rank as a scholar are evident throughout: his corrections of the sacred text, in the second part, evince a perfect knowledge of the Hebrew, as well as of the classical languages; and his remarks on Deluc's hypothesis of the indefinite period of the Mosaical days of creation, and Saussure's nonsensical rhapsody from the summit of Ætna, vindicate his pretensions as a sound and formidable critic.

In conclusion, we earnestly recommend this book to the serious attention of our readers. Its philosophy is founded on that of Bacon and Newton; its reasonings on the mode of first formations and secondary causes, are in strict harmony with that philosophy, and at least as plausible as any that have been advanced by the Huttonian and Wernerian schools. Nor must the adherents to those systems object, that its referring many effects to the immediate agency of divine power, is merely a subterfuge to cut the knot of difficulty, until they can either teach us how to untie it, or find a more probable cause to which it may be attributed. When, to these considerations, we add its excellent moral and religious tendency, we think every candid judgment will admit, that the "Comparative Estimate" has accomplished its intended object; and that it is indeed well calculated to "relieve the minds of earnest and sincere inquirers from perplexity," by contravening the pernicious dogmas of pseudo-scientific scepticism, whether derived from the fossil exuviæ of a former race, or the recent reliquiæ of a modern dissecting-room—whether founded on the *chemical contrivances* of a *crystallizing chaos*, or the profound speculations of medullary matter!

ART. XVII. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XIII.

i. *Empirical Elements of a Table of* REFRACTION: computed from Observations communicated and reduced by STEPHEN GROOMBRIDGE, Esq., F.R.S.

PROFESSOR SCHUMACHER has lately published a very useful little volume of *Permanent Auxiliary Tables*. But with regard to the subject of Astronomical Refraction, he has left it entirely undecided, by which of the many systems a computer will be most justified in correcting his observations; so that it is probable that almost every unprejudiced and diligent astronomer will prefer those which appear to be the most elaborate, or of which the author or authors have acquired the highest mathematical reputation; a reputation which but too often tempts its professor to look down with contempt on physical truth.

The mode of examination, exemplified by the Editor, in the former numbers of these Collections, appearing to him to be the only unexceptionable mode of obtaining a fair determination of this complicated question, he has prevailed on the kindness of Mr. Groombridge to add a number of later and more extensive observations to those which he had before communicated; and their ultimate results are here exhibited, with the addition of some further steps towards an immediate application to practice, or at least to a more satisfactory comparison of the merits of the different tables actually existing: and these results are not made public with the less readiness, because they appear, in some respects, not to agree quite so well with the Editor's own theory, as the former; but confirm the suspicion, which he formerly entertained, that the corrections of his table are somewhat more strictly appropriate to the different mean temperatures of various climates, than to the occasional variations at any one place.

The steps of the computation, with a little variation from those before enumerated, have been nearly these. First, to find the mean apparent altitude for each star. Secondly, to find the mean height of the exterior thermometer. Thirdly, to reduce all the refractions to their mean state of pressure, with the barometer at 30 inches, applying corrections, simply proportional to the differences, in the usual manner. Fifthly, to find the mean refraction, and the several differences from the mean, and to add together such of them as are regular, that is, such as agree with the differences of the thermometer in their character, and to subtract the sum of such as are irregular. Fifthly, to divide this result by the sum of the differences of the thermometer, in order to obtain the experimental correction for temperature; which must, however, be increased by the variation of refraction corresponding to such a supposed change of altitude. Sixthly, Mr. Groombridge having always reduced the temperature of his interior thermometer to 55°, in registering the height of the barometer, it will be necessary to make a slight correction for the difference of this temperature from the mean height of the exterior thermometer, in order to continue the mode of computation before adopted. Seventhly, it is obvious that if the tables and the observations were both perfect, the correction for temperature, thus determined, ought also to reproduce the observed refraction from the standard temperature of the tables; but this is seldom correctly true, and least of all where the number of observations compared are few, although they may not deserve to be wholly rejected. We may, therefore, divide the difference of refraction from that of the standard temperature, as exhibited in any tolerable tables, by the difference of the mean temperature from the standard temperature of those tables, for the joint result of the observations and tables.

Eighthly, this operation evidently supposes the standard refraction of the tables to agree with the observations; but, as a test of this agreement, it will be proper to divide the sum of the whole amount of the corrections, additive and subtractive, by the sum of the several differences from the standard temperature respectively: and it appears that in order to bring these quotients to equality, it will be necessary to alter the supposed standard of the tables to 46°, instead of 48°. Ninthly, we may ultimately adopt, as the best *empirical correction* to be derived from that set of observations, the mean of the two corrections thus obtained. Tenthly, the last column of the table contains the quotient of the refraction at the standard temperature, divided by this mean correction: it will be justifiable, in the present case, to reject two extravagant numbers, derived from 7 and 9 observations respectively; and, in order to satisfy the most scrupulous, we may venture to reject the least of all the numbers: hence, for the mean of the whole 20, we have 438.3; for the mean of the lower 10, 434.3, and of the upper 10, 442.3; half the difference 4, applied to the means, gives for the lower extreme 430.3, and for the upper 442.3, the difference of altitude being 7° 2′: and we may safely adopt, as the general empirical correction for each degree of temperature, as far as these observations go, the formula $\frac{\mathrm{R}}{430 + 2\ \mathrm{ALT.}^{\circ}}$. The first star observed ought also to have been rejected in this computation, as affording an irregular result, or too great a refraction: but it remains to be ascertained whether the error is in the observation or in the table: and, in fact, the empirical formula, here investigated, will not afford a series of mean refractions agreeing very accurately with any existing table; although we may safely infer from it, that the French astronomers were too precipitate in neglecting the true correction for temperature which their own theory would have afforded them, in opposition to the actual observation of Bradley, which had induced him to employ a correction somewhat more considerable than the mean of the results from Mr. Groombridge's observations.

EMPIRICAL TABLE OF REFRACTION.

STAR.	Obs.	Mean apparent Altitude	Mean Fahr.	Mean Refraction B. 30	Correction for — 1° Fahr.					Mean Divisor
					Obs. only	Obs. and T.	N. A.	Bessel	Fr. T.	
		° ′ ″	°	′ ″	″	″	″	″	″	
ε Pers.	16	1 18 42.6	49.2	22 23.3	2.27	−(6.0)	4.3	3.9	2.7	
γ Cygni ..	25	1 30 9.5	38.1	21 38.0	3.25	3.2	4.0	3.7	2.6	349
β Pers.	17	2 0 8.1	52.9	18 11.1	2.17	1.8	3.2	30	2.2	630
[α Lyræ ..	44	2 17 35.2	31.9	17 38.9	3.01	1.8	2.8	2.7	2.1]	406
ζ Aur.	13	2 30 53.4	56.7	15 51.6	2.35	2.9	2.7	2.5	1.9	404
η	9	2 41 2.2	56.3	15 18.3	1.17	1 3	2 5	2.4	1.8	(818)
β Boot.	5	2 51 34.5	28.7	15 32.7	2.99	1.6	2 5	2.3	1.8	377
ο Andr	12	3 2 29.9	38 9	14 44.7	2.43	2.0	2.3	2.2	1.8	(324)
γ	10	3 6 50 9	54.3	13 53.5	2.32	3.3	2.2	2.1	1.7	352
	8	3 53 37.5	39.8	12 17.4	2.00	1.4	1.8	1.8	1.4	406
μ Urs. Maj.	10	4 7 2.5	32.8	12 1.6	2.53	1.67	1.66	1.76	1.45	350
ξ Cygni ..	15	4 49 8.7	38.6	10 21.7	1.86	0.58	1.43	1.45	1.23	474
κ Andr. ..	12	4 55 27.2	43.5	10 10.0	1.34	0.86	1.40	1.44	1.20	422
11 Lacert.	16	4 55 55.7	38.3	10 12.8	1.47	0.80	1.40	1.44	1.20	491
ε Aurig. ..	7	5 9 17.7	58.2	9 29.8	1.22	1.30	1.34	1.37	1.16	507
λ U. Maj.	11	5 27 58.5	33.8	9 28.5	1.44	1.03	1.27	1.29	1.14	420
κ Pers.	13	5 44 33.2	53.8	8 41.4	1.16	1.62	1.21	1.22	1.06	442
ω U. Maj...	13	5 47 55.9	33.6	8 57.5	1.83	0.73	1.20	1.21	1.05	393
α Cygni ..	29	6 13 12.7	38.5	8 20.8	1.19	0.49	1.11	1.14	1.00	548
β Aur.	23	6 30 26.4	58.3	7 46.4	1.10	1.09	1.03	1.06	0.93	488
ψ U. Maj.	7	7 6 8.5	33.7	7 31.4	0 87	0.45	0.95	0.96	0.87	(653)
Capella ...	24	7 22 13.6	61.8	6 58.0	1.18	1.59	0.93	0.93	0.84	340
τ Herc.. ..	13	8 20 21.3	39.9	6 36.5	1.09	0.86	0.82	0.84	0.80	372

ii. *Errors of the Lunar Tables for* 1819 *and* 1820. *Computed from the Observations made at Greenwich.*

(See Collections III. ii.)

Laplace and Burg.	Mean Error Long.	Mean Error Lat.	Greatest Error of three consecutive observations in Longitude.
	″	″	″
1820	±5.3 −1.7	7.6	16.6
Laplace and Burckhardt.			
1820	±4.4 +3.4	5.7	11.0
1821	±4.4 − .3	4.3	11.1

iii. *Mr.* RUMKER'S *rediscovery of* ENCKE'S *triennial Comet. In a Letter to the Editor.* (See Collections IV. ii.)

SUMMER SOLSTICE, 1822, observed in Paramatta Observatory, with a repeating circle of Reichenbach. The observations of the Solstice are partly by the Governor, partly by myself.

Day of the Month	True Zen. Dist. of the Sun's Centre	Reduction to the Solstice	Cor. for Sun's Lat.	True Zen. Dist. of Trop. of ♋	Bar.	Ther.
	° ′ ″	′ ″	″	° ′ ″	″	″
June 9	56 41 49.63	34 40.67	+0.41	57 16 30.7	29.97	55.4
10	46 59.97	29 33.96	0.26	34.19	29.8	56.0
13	59 52.98	16 38.49	−0.19	31.28	29.8	63.0
14	57 3 29.98	13 7.82	0.29	37.51	29.85	59.5
15	6 30.19	10 3.52	0.31	33.40	30.09	59.0
16	9 11.80	7 22.98	0.41	34.37	30.06	54.0
18	13 19.11	3 16.16	0.39	34.88	29.90	59.5
19	14 42.88	1 49.86	0.32	32.42	29.81	52.0
20	15 44.9	0 48.41	0.22	33.31	29.92	51.0
21	16 18.51	11.77	0.12	30.16	29.90	51.5
23	16 14.57	13.07	+0.17	27.81	29.71	57.0
28	9 2.6	7 29.89	0.81	33.3	30.04	61.2
29	6 20.16	10 11.38	0.85	32.39	29.99	59.0
30	3 12.41	13 17.27	0.88	30.56	30.00	56.0
July 1	56 59 45.81	16 47.43	0.88	34.12	30.00	56.0

Mean	57 16 32.687
Lunisolar nutation	− 6.77
Reduction to Jan. 1, 1822 .	57 16 25.917
	+ 0.22
Mean Z. D. of Tropic of ♋ . . .	57 16 26.137
The Winter Sols. gives m. Z.D. of Trop. of ♑	10 21 2.237
Difference . . .	46 55 23.9
Hence mean obliq. Jan. 1, 1822,	23 27 41.95

Supposing the mean obliquity Jan. 1, 1822, to have been 23 27 44.26, we obtain for lat. of the observatory 33 48 41.97.

I observed the following occultations of fixed stars at Paramatta.

					Mean Time.
March	28, 1822,	✳ 7 magnitude	Tauri	immers.	6 54 30.2
	30	5.6 supposed	υ Gemi.		9 19 28.5
April	1	6	Cancri		8 58 21.8
	10	Antares		immers.	18 35 47.4
				emersio	19 14 27.9
					Sidereal Time.
July	11	5.6	Pisc.	immers.	2 1 0.4

From the occult. of Antares I find the mean time at Paramatta of true conjunction,—

Per imm. 17 29 8.8 $-5.54\,dL + 5.89\,dS - 0.56\,d\pi$
emer. . . . 19.82 $+2.44$ . . -3.17 . -2.06

From the Nautical Almanac follows the mean time of ☌ in Green. 7 25 12.5. Hence long of Par. $10^h\ 4'\ 1''.8$; this may, however, be corrected by the Green. Lunar Obs. on that day.

I assumed $\frac{303}{304}$ for ratio of earth's axes.

Opposition of Mars, February, 1822.

These observations are a mean of several observations about the meridian, each being singly reduced to the time of culmination. I made the observations with a repeating micrometer, applied to a telescope on an equatorial stand, and did not extend them beyond 15′ on each side of the meridian.

		Sid. Time.		In arc.
Feb. 15	Mars less AR than i Leonis	1′ 47″.33	Mars N. of i ♌	2′ 35″.15
16	Mars more AR than 446 Mayer	0 6. 05	Mars South of 446 M.	0 34. 8

On the 15th of February, at the time of culmination, Mars was therefore 2′ 35.″15 north of i Leonis and on the 16th, when on the meridian 0′ 34.″84 south of 446 Mayer, which latter star it must have eclipsed little after passing the meridian; clouds prevented me from seeing it: thence the parallax of Mars might be inferred.

Comet of Encke.

I did not see this comet before the second of June, 1822. I send you here my observations thereof, which I believe to be so correct as the position of the stars which I used for comparison, taken partly from Piazzi, but chiefly reduced from La Lande *Histoire Céleste.*

	Sinereal Time	Mean AR.	Mean Dec.	
June 2	10 39 25	92 43 51.3	17 39 46.3	North
3	11 ——	93 46 20.7	16 53 7.5	
4	11 3 0	94 46 0.0	16 4 36.7 .	
6	11 7 38	96 42 11.6	14 22 42	
7	11 3 10	97 38 15	13 26 5	
8	11 17 25	98 33 47.7	12 31 18.6	
10	11 20 0	100 24 43.8	10 29 49.5	
11	11 24 39	101 19 44.5	9 25 4.6 .	
12	11 40 0	102 17 52	8 18 30	
13	11 42 4	103 15 2	7 6 30	
14	11 55 0	104 15 40	5 52 27	
15	11 40 48	105 17 0.5	4 33 40 .	
19	12 13 38	109 54 36.4	1 29 43.7	South
20	12 16 53	111 14 26.9	3 14 29.1 .	
22	13 18 46	114 12 20.5	7 8 ——.	
23	12 53 55	115 47 41.7	9 9 48.4 .	

After the 23d the moonlight was too bright, and after full moon the comet was too faint to permit observations to be made.

8 digits of the sun will be eclipsed at Paramatta on Aug. 17, in the morning. But the eclipse will be total at Cape Bedford, in lat. 15° 27′ south, and long. 145° 30′ east.

Dear Sir, I beg you will dispose of these observations according to your pleasure. * * * Your most obedient Servant,

July 23,1822. CHAS. RUMKER.

iv. *Predicted and observed Places of the Principal Stars.* By JOHN POND, Esq., F.R.S., Astronomer Royal.

From the Philosophical Transactions.

1756 comp. with 1813 Ann. Var. 1818	No.	Names of Stars.	AR 1 Jan. 1823	Predicted N.P.D. 1823. 1756 and 1813	Observed. (Bradley's Refract.) Ther. In.	Star's obs. South of predicted place.
			h m s	° ′ ″	° ′ ″	″
−20.09	1	γ Pegasi	0 4 8.09	75 48 0.11	75 48 2.3	2.2
−19·85	2	α Cassiop....	0 30 31.29	34 26 4.23	34 26 5.7	1·5
	3	Polaris......	0 57 46.38		1 38 7·5	
−17.40	4	α Arietis	1 57 13.99	67 22 42.60	67 22 44.4	1.8
−14.59	5	α Ceti	2 53 2.29	86 36 34.86	86 36 36.8	2.0
−13.41	6	α Persei	3 11 44.48	40 46 38.34	40 46 39.0	0.7
− 7.92	7	Aldebaran ..	4 25 46.58	73 51 16.17	73 51 17·7	1.5
− 4.54	8	Capella	5 3 37.83	44 11 35·11	44 11 36·8	1.7
− 4.74	9	Rigel	5 6 2.21	98 24 46.44	98 24 48.4	2.0
− 3.80	10	β Tauri	5 15 6.76	61 33 5.74	61 33 6.6	0.9
− 1.36	11	α Orionis....	5 45 35.66	82 38 2.11	82 38 4·2	2 1
+ 4.41	12	Sirius	6 37 20.85	106 28 45.35	106 28 48·7	3·4
+ 7.12	13	Castor	7 23 17.62	57 43 58·08	57 43 59·1	1.0
+ 8.63	14	Procyon	7 30 2.19	84 19 40.75	84 19 43·2	2 4
+ 8.02	15	Pollux	7 34 28 52	61 33 16.76	61 33 17·1	0.3
+ 15·19	16	α Hydræ	9 18 53·50	97 53 43·20	97 53 44.5	1.3
+ 17·23	17	Regulus	9 58 56·36	77 10 15.00	77 10 15·4	0.4
+ 19.26	18	α Urs. Maj...	10 52 43·41	27 17 44·16	27 17 43·8	−0.4
+ 20.04	19	β Leonis	11 40 1·66	74 26 17·73	74 26 18·1	0.4
+ 19·98	20	γ Urs. Maj...	11 44 28.63	35 19 15·18	35 19 14·8	−0.4
+ 18·94	21	Spica Virginis	13 15 52.91	100 14 0·73	100 14 0·7	0.0
+ 18.15	22	η Urs. Maj. ..	13 40 33.54	39 47 59·60	39 47 59·5	−0·1
+ 18·97	23	Arcturus....	14 7 35.61	69 53 28.83	69 53 29·2	0.4
+ 15·30	24	1 α Librae	14 40 54.93	105 17 55.67	105 17 56.3	0.6
+ 15.32	25	2	14 41 6.36	105 15 11.91	105 15 12·5	
+ 14.74	26	β Urs. Min. ..	14 51 19·53	15 7 16.38	15 7 15.7	−0.7
+ 12.45	27	α Cor. Bor. ..	15 27 11.95	62 41 0.07	62 41 0·6	0.5
+ 11.72	28	α Serpentis ..	15 35 33·53	83 0 36·52	83 0 36.6	0.1
+ 8.59	29	Antares	16 18 34·23	116 1 42·50	116 1 44·1	1.6
+ 4.57	30	α Herculis ..	17 6 35·00	75 23 59·70	75 24 0.1	0.4
+ 3·08	31	α Ophiuchi ..	17 26 43·49	77 18 9.74	77 18 10.6	0.9
+ 0.67	32	γ Draconis ..	17 52 30·14	38 29 10.31	38 29 10.5	0.2
− 3.02	33	α Lyræ......	18 30 56.98	51 22 30.37	51 22 31.2	0.8
− 8.34	34	γ	19 37 50·82	79 48 35·53		
− 9.06	35	α Aquilæ ..	19 42 8·94	81 35 28·31	81 35 29.5	1,2
− 8·56	36	β	19 46 37·27	84 1 37·94		
−10·66	37	1 αCapricor.	20 7 49·91	103 2 48·83	103 2 49.6	1.0
−10·68	38	2	20 8 13.69	103 5 5·45	103 5 6.6	
−12·63	39	α Cygni	20 35 24.19	45 20 50·80	45 20 52.4	1.6
−15 07	40	α Cephei ..	21 14 21.05	28 9 42·20	28 9 42.8	0.6
−15.68	41	β	21 26 20·44	20 12 53·78	20 12 54.0	0.2
−17·27	42	α Aquarii	21 56 41·55	91 10 28·85	91 10 31.4	2.5
	43	Fomalhaut ..	22 47 50·97			
−19.32	44	α Pegasi	22 55 57·20	75 44 38.52	75 44 41.8	3·3
−19·95	45	α Andromedæ	23 59 15.61	61 53 10.75	61 53 12.5	1.8

NOTE. The sign − in the last column denotes that the Star has been found north of its predicted place.

Art. XVIII.—MISCELLANEOUS INTELLIGENCE.

I. MECHANICAL SCIENCE.

1. *Economical Bridge.*—A bridge of suspension, or rather tension, has been constructed not long since by M. M. Seguin, near Annonay, department de l'Ardêche, after the model of those constructed by the indigenous inhabitants of America*. The following account is taken from a description of it by M. Pictet. *Bib. Univ.* xxi. 123.

At the place where it is constructed, the river over which it passes is confined by rocks which have furnished strong points of attachment for the bridge. A band composed of eight iron wires, each the $\frac{1}{22}$ of an inch in diameter is attached by its extremity to an iron bolt fixed in the rock; it then crosses the river at a height of 10 feet above it, and on the opposite side passes round a horizontal pulley three inches in diameter, also made fast to a rock. The band returns parallel to its first direction, passes round one pulley to preserve the parallelism, and then on to another about 16 inches distant, from which it again proceeds over the river and passes round a second pulley on that side, and finally returns to the side from which it parted, and is made fast to a bolt in the rock. Thus it crosses the river four times. Small cross pieces of wood are attached at intervals to these reduplications of the band, and over them are placed the planks, parallel to the wires, which form the foot-way of the bridge. Two other bands of wire are carried across the river at a convenient height on each side of the bridge, to serve as hand-rails; they are connected by descending wires to the external bands of the bridge: and, to prevent every lateral motion the bridge is made fast at the middle to some large stones in the bed of the river.

This bridge though of a structure so light as to occasion fear on the first time of going on to it, is yet so steady and strong that no sensible bending or vibration is perceived in passing over it. It is 2 feet broad, and 55 feet long. The weight of iron wire used in its construction was about 24lb., and the expense of the whole of the materials amounted to little more than 35 francs. The expense of labour is estimated at about 15 francs, so that 50 francs according to this account would pay for the whole.

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* See also vii. 53.

2. *Hydraulic Instrument for raising Water.*—It is well known that if a glass vessel containing water be placed in the centre of a whirling table, the water, by the centrifugal force, will be thrown from the centre outwardly, and the surface of the water will assume a form approaching to that of a parabola.

Dr. Crelle, architect to the King of Prussia, has accordingly made the bent tube in his model of the improved Hessian machine of a parabolic shape, and on being placed in a certain depth of water, the water entering below at a hole in the centre of the tube, is by the quick whirling movement given to the machine, raised and delivered at the upper ends of the tube into the circular trough, and runs out from thence at a spout on one side of it. Many tubes may be thus combined, and the quantity of water raised be increased accordingly. The value of this machine on a large scale is not known, but certainly this is the best form of it.—*Tech. Rep.* iii. 99.

3. *Hydroparabolic Mirror—standard Measure.*—Mr. Busby, well known as the constructor of a hydraulic orrery, applies the syphon as a generator of rotary motion. A floating circular vessel is placed in a reservoir of water, and has a syphon attached to it, one leg of the syphon dips into the water of the reservoir, the other passes over the side of the reservoir to a lower level than the water within, and discharging a minute stream by a lateral aperture, gives to the floating vessel a perfectly equable revolving motion. By means of it, Mr. Busby says he has produced a perfect hydroparabolic mirror fifty-four inches in diameter, thus being able to create any magnifying power *ad libitum.* He refers to it also as a means of obtaining an universal standard of measure. Thus, a given parabolic speculum will invariably be formed by any given rotation at any known level and latitude, and the focal distance of any parabola must under those circumstances be always a given dimension.—*Tran. Soc. Arts*, xl.

4. *Feeding of Engine Boilers.*—Thomas Hall, engineman to the Glasgow Water Company, having remarked the waste of fuel which occurred at those times when a steam-engine stopped working, as at night, &c., was induced to alter his mode of feeding the boilers with water, with a view to prevent as much of this waste as possible. Instead of letting in a continual supply of water, equal to the portion converted into vapour, he took every opportunity, when the engine was stopped for a

sufficient time (30 or 40 minutes,) as at meal time, night, &c., of introducing water into the boiler to as much as 18 inches above its usual level, and it was continued to this higher level as long as the engine was off work. When labour was resumed, there was therefore an abundant supply of hot water in the boiler, the steam was ready, and no increase of fire, to heat freshly-introduced water, required. The saving which arose from this mode of management was 25 per cent. of the fuel. The apparatus for feeding the boiler in this manner with accuracy, and without trouble, is very ingenious, and is described in the *Trans. Soc. Arts*, xl. 127.

5. *Improved Printing.*—A great improvement in printing is spoken of as the invention of Mr. Church, of America, who is now in London, constructing a machine, which it is hoped will be successful. The improvement extends to casting as well as composing, and by simplifying the casting process, and saving the expense of distributing, he proposes to compose always from new types, remelting after the edition is worked off. The recasting for every new composition is connected with the regular laying of the types, and when thus laid, it is intended to compose by means of keys, like those of a pianoforte, each key standing for a letter, or letters. By these means errors would be avoided in the composition, and the progress would be far more rapid than at present.

The above is the only account we have been able to procure of the improvement; and we gather from it, that it should rather be considered as intended, than as realized.

6. *Casting of Stereotype-plates, by M. Didot.*—This method consists in striking moveable characters (cast of a composition hereafter to be described,) into lead, without the assistance of heat. Moveable characters formed of that composition, cast in the usual manner, are composed line by line, according to the common methods, till a page is formed. This page is placed in a frame of suitable dimensions, and in this frame two quadrats are placed, which, by means of screws, press all these moveable letters so as to form a solid mass. A brass or iron frame is made to the size of the page, and a plate of iron is fastened to it by screws, to serve as a bottom; this frame is then filled with a plate of pure lead. The whole being thus prepared, the page composed of moveable characters is put upon the lead

intended for a matrix; it is then placed under a strong press, which forces down the letters into the lead, which thus becomes a solid matrix. In this matrix as many stereotype forms may be cast as can be wanted. The composition for casting the moveable characters is formed of seven parts by weight of lead, two of regulus of antimony, and one of an alloy of tin and copper, in the proportion of nine of tin, to one of copper.—*New Monthly Magazine*, ix. 71.

The alloy with which to cast the *plates* should also have been described.—Ed.

7. *Calculating Engine.*—At page 222, of our 14th volume, we have inserted a notice of Mr. Babbage's very curious investigations on the application of machinery to the purpose of calculating and printing mathematical tables. It gives us much pleasure to be able to inform our readers, that he is diligently pursuing this very important subject, and that the results of his labours are in the highest degree satisfactory.

8. *English Opium.*—Messrs. Cowley and Staines, of Winslow, Bucks, have cultivated poppies for opium with such success, as to induce the belief that that branch of agriculture is of national importance, and worthy of support. In the year 1821, they produced 60 lbs. of solid opium, equal to the best Turkey opium, from rather less than four acres and a half of ground. The seed was sown in February, came up in March, and, after proper hoeing, setting out, &c., the opium gathering commenced at the latter end of July. The criterion for gathering the opium was, when the poppies, having lost their petals, were covered with a bluish-white bloom. The scarificator, an instrument containing five small blades, was then applied to them, horizontal incisions being preferred, because the juice was not so apt to run from them before inspissation. After being scarified in one aspect, the head was left until the juice was coagulated (about two hours,) it was then removed by gatherers, and fresh incisions made on other parts. The poppies were found to produce opium freely, until the third or fourth incision, and some of them even to the tenth. Opium was gathered daily until, at the rate of 30*s.* per lb., the produce would no longer bear the expense; 97 lb. 1 oz. were procured at an expense of 31*l.* 11*s.* 2½*d.*, and this, when evaporated sufficiently in the sun, produced above 60 lb. of properly dried opium.

The poppies stood on the stalks until they began to turn yellow (Aug. 18,) they were then pulled and laid in rows on the land, and, when sufficiently dry, the heads were gathered, thrashed, and the seed separated by coarse riddles, and cleaned by fine sieves and a fan. The seed amounted to 13 cwt., and was expected to produce 71½ gallons of oil. The oil-cake was given to pigs with great advantage, and also to stall-feeding cattle. An extract may also be made, by cold infusion, from the capsule of the poppy, eight grains of which are equal to one of opium; an acre produces 80 lb. of it. The poppy straw when well trodden in the yard, and laid in a compact head to ferment, makes excellent manure.

The quantity of opium consumed in this country is supposed to amount annually to about 50,000 lb., exclusive of exportations. This quantity (say Messrs. Cowley and Staines), our experiments have convinced us, could be easily raised in many parts of Great Britain, where good dry land and a superfluous population exist together. On the moderate calculation of 10 lbs. per acre, that quantity would only require 4 or 5000 acres of land, and from 40 to 50,000 people. The employment would be given to such persons as are not calculated for common agricultural labour, and at a time when labour is wanted, namely, between hay-time and harvest.—*Trans. Soc. Arts*, xl. 9.

9. *British Indigo.*—A discovery has been recently made, which promises the most important consequences in a commercial and agricultural point of view. About two years ago, 280 acres of land near Flint, in Wales, were planted with the common hollyhock, or rose-mallow, with the view of converting it into hemp or flax. In the process of manufacture it was discovered that this plant yields a beautiful blue dye, equal in beauty and permanence to the best indigo.—*New Monthly Mag.* ix. 22.

We should be glad to have this confirmed.

10. *Preservation of Grain, &c., from Mice.*—Mr. Macdonald, of Scalpa, in the Hebrides, having some years ago suffered considerably by mice; put at the bottom, near the centre, and at the top of each stack, or mow, as it was raised, three or four stalks of wild mint, with the leaves on, gathered near a brook, in a neighbouring field, and never after had any of his grain consumed. He then tried the same experiment with his cheese and other articles kept in store, and often injured by mice; and

with equal effect, by laying a few leaves, green or dry, on the article to be preserved.—*Phil. Mag.*

11. *Preservation of Turnips.*—Messrs. Staines and Cowley preserve turnips during the winter for cattle-feeding, by cutting off the tops, taking especial care not to injure the crowns, and then piling them up methodically on straw into a heap, covered exteriorly with straw. In this way they were found to keep in a perfectly sound state during the winter, and to be excellent food for cattle.—*Trans. Soc. Arts*, xl. 29.

12. *Yeast.*—The following methods of making yeast for bread are easy and expeditious. Boil one pound of good flour, a quarter of a pound of brown sugar, and a little salt, in two gallons of water for an hour; when milk-warm, bottle it and cork it close; it will be fit for use in 24 hours. One pint of it will make 18lb. of bread.—To a pound of mashed potatoes (mealy ones are best), add two ounces of brown sugar and two spoonfuls of common yeast, the potatoes first to be pulped through a cullender, and mixed with warm water to a proper consistence. A pound of potatoes will make a quart of good yeast. Keep it moderately warm while fermenting. This recipe is in substance from Dr. Hunter, who observes that yeast so made will keep well. No sugar is used by bakers when adding the pulp of potatoes to their rising.—*Yorkshire Gazette.*

13. *Prevention of Dry Rot.*—From an observation of the power of perfumes in preventing mouldiness, Dr. Mac Culloch was led to make some trials on wood, with a view to the prevention of dry rot. The results were favourable, but Dr. M., not having power to resume the experiments, recommends them to other persons. A cheap odorous oil is the substance required.

14. *Paste.*—Dr. Mac Culloch, in a paper on the power of perfumes in preventing mouldiness, gives the following directions for the preparation of a paste, which, as it will keep any length of time, and is always ready for use, may be of great service to mineralogists and others. "That which I have long used in this manner is made of flour in the usual way, but rather thick, with a proportion of brown sugar, and a small quantity of corrosive sublimate. The use of the sugar is to keep it flexible, so as to prevent its scaling off from smooth

surfaces; and, that of the corrosive sublimate, independently of preserving it from insects, is an effectual check against its fermentation. This salt, however, does not prevent the formation of mouldiness; but, as a drop or two of the essential oils above-mentioned, (lavender, peppermint, anise, bergamot, &c.,) is a complete security against this, all the causes of destruction are effectually guarded against. Paste made in this manner and exposed to the air, dries without change to a state resembling horn, so that it may at any time be wetted again, and applied to use. When kept in a close covered pot, it may be preserved in a state for use at all times."—*Edin. Jour.* viii. 35.

15. *Improved Glaze for Red Ware.*—The common red ware much used in the manufacture of cooking-vessels for the lower class of people, is generally glazed either with litharge, or the potter's lead ore. This glaze is objectionable, not only because it cracks when the vessels are heated and cooled, but also from its being soluble in vinegar, acid juices, and animal fat, and producing very deleterious effects. Mr. Meigh of Shelton, Staffordshire, has been rewarded by the Society of Arts for the discovery of a glaze, having none of these bad properties. Red marl is first ground in water until it forms a creamy mixture; the ware, previously well dried but not burnt, is then immersed in it, by which the superficial pores are filled up. Being again well dried, it is dipped in the glaze, which consists of one part Cornish granite, chiefly felspar, one part glass, one part black oxide of manganese, ground in water to the consistency of cream. The ware is then dried and fired in the usual way. If an opaque white glaze is required, the manganese is to be omitted.

Mr. Meigh has also manufactured an improved common ware from a mixture of four parts common marl, one part of red marl, and one part of brick clay. It is harder, more compact, and less porous than the common red ware, and when combined with the above glaze, produces vessels very superior for those uses to which the red ware is applied.—*Trans. Soc. Arts,* xl. 45.

16. *Soldering Sheet Iron.*—Sheet iron may be soldered by means of filings of soft cast-iron applied with borax, deprived of its water of crystallization and sal ammoniac. Tubes of sheet iron have been constructed at Birmingham lately by means

of a process of this kind, which, according to Mr. Perkins and Mr. Gill, is to be practised in the following manner:—The borax is to be dried in a crucible, not till it fuzes, but till it forms a white crust; then powdered and mixed with the iron filings: the joint is to be made bright and moistened with a solution of the sal ammoniac; then the mixture is to be made into a thick paste with water, and placed along the inside of the joint, and the whole heated over a clear fire till the cast-iron fuzes.—*Tech. Rep.* iii. 110.

17. *New Form of the Voltaic Apparatus.*—Mr. Pepys has constructed, at the London Institution, a single coil of copper and zinc plate, consisting of two sheets of the metals, each fifty feet long by two feet broad, having therefore a surface of 200 square feet; they are wound round a wooden centre, and kept apart by pieces of hair-line, interposed at intervals between the plates. This voltaic coil is suspended by a rope, and counterpoise over a tub of dilute acid, into which it is plunged when used.

It gives not the slightest electrical indications to the electrometer; indeed, its electricity is of such low intensity that well-burned charcoal acts as an insulator to it; nor does the quantity of electricity appear considerable, for it with difficulty ignites one inch of platinum wire of $\frac{1}{30}$ inch diameter. When, however, the poles are connected by a copper wire $\frac{1}{8}$ inch diameter and 8 inches long, it becomes hot, and is rendered most powerfully magnetic, and the instrument is admirably adapted for all electro-magnetic experiments. Dr. Wollaston's well-known and curious arrangement of a single pair of plates, may justly be called a *Calorimotor;* and to Mr. Pepys's coil we may apply the term *Magnetomotor.*

18. *Patent Portable Static Lamp.*—A lamp under this name has just been perfected by Mr. Parker, of Argyll-street. Its chief merit is, that the oil is raised to the burning height without springs, valves, or screws, and in a manner not liable to get out of repair. To render its principle and construction intelligible the following short account of the ingenious method by which Mr. Parker has effected his object, will probably be sufficient; in our next Number we shall describe it more accurately with the aid of a plate.

A cylindrical vessel, open at top, $3\frac{8}{12}$ inches diameter, and

3 inches high, contains the oil; in its centre is affixed a strong iron rod, upon which the upper part of the lamp, hereafter to be described, moves.

Another cylindrical vessel, open at top, 3$\frac{10}{12}$ diameter, and 7 inches high, surrounds the oil vessel, leaving a space of $\frac{2}{12}$ of an inch between the two vessels. These vessels are then united at bottom, and made air-tight, and the $\frac{2}{12}$ space filled with mercury.

Another cylindrical vessel (called the plunging cylinder, because it plunges into the mercury in the $\frac{2}{12}$ space), closed at top, and open at bottom (3$\frac{9}{12}$ diameter, and 3 inches high), is firmly attached to the connecting tube and burner of the lamp, the tube ascending to the required height of the light, and descending to the lower level of this plunging vessel. This tube moves up and down the centre iron rod on points, or pins, to prevent friction or capillary attraction.

The oil-vessel being filled with oil, and the $\frac{2}{12}$ space with mercury, it is evident the plunging vessel, and oil-tube attached thereto, entering the mercury and oil at the same time, in the manner of a gasometer, the air contained in the plunging vessel cannot escape, and the whole weight of the plunging vessel (which is loaded to raise the oil the required height,) presses upon the oil, through the elastic medium of air, and forces the oil up the centre tube to the adjusted height. This action continues until all the oil is consumed.

The advantages of this lamp are, that it burns till all the oil is consumed.

That the oil and weight being in the base, it is not liable to be overthrown, nor can any oil be spilt.

That it is as perfectly shadowless as a gas-light, and capable of as much beauty of form.

That there being neither valve, spring, nor screw, it is not liable to be out of repair, and is easily managed by servants, the oil being poured into an open vessel, instead of a small aperture. The mercury is never removed.

That being made of iron, it is not the least acted upon by oil. It may also be mentioned, that the oil tubes clean themselves every time the lamp is charged with oil.

That, independent of less first cost than other lamps of equal appearance, it is economical in other respects. No light is wasted, as in the French, or even the Sinumbra lamps, for though in the latter the shadow projected from the ring reservoir is overcome, it is only by calling in aid the rays of light from other parts of the flame, while those striking against the ring reservoir are lost for the purpose of illumination.

II. CHEMICAL SCIENCE.

1. *On the Action of Heat and Pressure on certain Fluids. By* M. le Baron Cagniard de la Tour.—It is known, that by means of Papin's digester, the temperature of many fluids may be raised much above their ordinary boiling points; and one is led to suppose, that the internal pressure augmenting with the temperature, would prove an obstacle to the total evaporation of the fluid, especially if the space left above the fluid is not of a certain extent.

Reflecting on this subject, it occurred to me that there was necessarily a limit to the dilatation of a volatile fluid, beyond which it would become vapour, notwithstanding the pressure, if the capacity of the vessel would permit the liquid matter to extend to its maximum of dilatation.

To ascertain this point, a certain quantity of alcohol, sp. gr. .837, and a sphere of silex, were put into a small digester, made out of the thick end of a musket barrel, the liquid occupying the third of the capacity. Having observed the noise produced by the sphere, when rolled in the cold apparatus, it was gradually heated until a point was reached, when the ball seemed to bound from end to end of the digester, as if no liquid had been present. This effect, easily distinguished by holding the end of the handle to the ear, ceased on cooling the apparatus, and was reproduced on re-heating it.

The same experiment made with water, succeeded only imperfectly, because of the high temperature required interfering with the tightness of the instrument. But sulphuric ether and naphtha presented the same results as alcohol.

That the phenomena might be observed with more facility, the liquids were introduced into small tubes of glass, and hermetically sealed. A handle of glass was attached to each tube. A tube was two-fifths filled with alcohol, and then slowly and carefully heated; as the fluid dilated, its mobility increased, and, when its volume was nearly doubled, it completely disappeared, and became a vapour so transparent, that the tube appeared quite empty. On leaving it to cool for a moment, a very thick cloud formed in its interior, and the liquor returned to its first state. A second tube, nearly half occupied by the same fluid, gave a similar result; but a third, containing rather more than half, burst.

Similar experiments with naphtha, sp. gr. .807, and with ether, gave similar results. Ether required less space than naphtha, and naphtha less than alcohol, to become vapour; appearing to indicate, that the more a body is already dilated, the less additional volume does it acquire before it attains its maximum of expansion.

In all the previous experiments, the air had been expelled from the tubes; but repeated with others in which the air was left, the results were similar, and the phenomena more readily observed, from the absence of ebullition.

A last trial was made with water in a tube of glass, about one-third of its capacity being occupied by the fluid. This tube lost its transparency, and broke a few instants after. It appears, that by a high temperature, water is able to decompose glass, by separating the alkali; leading us to suppose, that other interesting chemical results may be obtained, by multiplying the applications of this process of decomposition.

On carefully watching the tubes in which air had been left, it was remarked, that those in which the fluid had not space for the maximum of dilatation preceding the conversion into vapour, did not always break as soon as the liquid appeared to fill the whole space; and that the explosion was the more tardy, as the excess of liquid above that required to fill the space was less. May not, then, the consequence be inferred, that liquids but little compressible at low temperatures, become much more so at high temperatures? And this is more likely in the case in question, where the fluid is just on the point of becoming elastic, under a pressure which, by theory, appears to be equal to many hundred atmospheres.

It is difficult to believe, that a little tube of glass, about $\frac{12}{100}$ of an inch internal diameter, and $\frac{1}{25}$ of an inch thick, could resist so considerable a force: perhaps it may be supposed, that the molecules of an elastic fluid, and particularly of vapour, are susceptible, under a certain compression and heat, of contracting a change of state comparable to that of a half fusion, and capable of facilitating a reduction of volume greater than that due to the true pressure.

Whilst waiting for new experiments on this subject, it appears that the following conclusions will include what has already been described:—1. That alcohol, naphtha, and sulphuric ether, submitted to heat and pressure, are converted into vapour, in a space a little more than double that of each liquid. 2. That an augmentation of pressure, occasioned by the presence of air, caused no obstacle to the evaporation of the liquid in the same space, but only rendered the dilation of the liquid more regular and observable. 3. That water, though susceptible of being reduced into very compressed vapour, has not yet been submitted to perfect experiments, because of the imperfect closing of the digester at high temperatures, and also because of its action on glass tubes.—*Annales de Chim.* xxi. 127.

In a supplement to the above Mémoire, M. Cagniard de la Tour states the results of experiments made to ascertain the pressure produced in the experiments described. The process adopted was to bend a tube into a syphon, place ether in one leg, and separate it from the other containing air, by mercury; both legs being sealed, the apparatus was heated, and when the ether became vapour, the diminution in the bulk of the air marked. In the present experiment, 528 parts became 14, a result which was thrice obtained. Ether, therefore, is susceptible of being converted into vapour in a space less than twice its original volume, and in this state it exerts a pressure of between 37 and 38 atmospheres.

When alcohol, sp. gr. 837, was used, 476 parts of air became 4; and from an observation of the volume, it was ascertained that alcohol may be reduced into vapour, in a space rather less than thrice its original volume, and that it then exerts a pressure of 119 atmospheres.

The temperature at which these effects took place was ascertained, by repeating the experiments in an oil bath. The ether required a temperature of 320°, F.; alcohol, that of 405°, F.

In the Mémoire it was announced, that water heated in tubes of glass altered the transparency, so as to prevent observation of what passed within; but M. Cagniard de la Tour found that a small quantity of carbonate of soda prevented, in a great measure, this effect. He was enabled therefore, though only with difficulty, from the frequent rupture of the glass tubes, to ascertain, that at a temperature but little removed from that of melting zinc, water could be converted into vapour, in a space nearly four times that of its original volume.—*Annales de Chim.* xxi. 178.

2. *Berthier on Sulphurets produced from Sulphates.*—The experiments made by M. Berthier had for their object the de-

termination of the composition and nature of certain sulphurets, such as those of the alkaline and earthy metals. "They have," says M. Berthier, "given me the means of resolving the question, till now undecided, whether the alkalies and alkaline earths are or are not in the metallic state in the sulphurets prepared by fire. They are so simple, that one is astonished they have not been made before; and it may be seen they conduct, in the most evident and direct manner, to the knowledge of the nature of the alkalies and alkaline earths."

The method by which M. Berthier reduces sulphates to sulphurets is not by directly mixing them with powdered charcoal, and heating them in a crucible, but by placing them in the centre of a crucible, thickly lined with charcoal, covering them with the same substance, and after having luted on a cover, heating the whole in a furnace. In this way the sulphates are reduced by cementation, as it were, the time required being proportioned to the temperature, the fusibility of the sulphurets, and the volume of the substance. All are reducible at a white heat, and, where the sulphuret is fusible, very quickly; but when it is infusible, it remains interposed between the charcoal and the sulphate, and the action is slower. An ounce of sulphate may in this case require above two hours. In this way not only are pure sulphurets obtained, but the result may be collected without the smallest loss, its weight ascertained, and the weight of oxygen evolved accurately estimated.

If a sulphate of baryta, strontia, or lime, be thus reduced to a sulphuret, and weighed, the loss will be found to equal exactly the quantity of oxygen contained in the base and acid. If the sulphuret be dissolved in muriatic acid, nothing will be liberated but pure sulphuretted hydrogen; no sulphur will be set free, nor any acid, containing sulphur and oxygen, formed; finally, if a portion of the sulphuret be heated in a crucible of silver, with nitre equal to three or four times its weight, the sulphate regenerated will correspond with the quantity of sulphuret employed, and will contain neither acid nor base in excess. These three experiments prove that the sulphuret produced contains no oxygen, and, consequently, that the base is in the metallic state; and if, in addition to these means of analysis, the experiment be made in close vessels, and the gaseous products collected and analyzed, it will be found that the loss of weight sustained by the sulphate is exactly made up by the quantity of oxygen given off.

The following are some of the results obtained by this mode of operation. *Sulphuret of Barium.*—White and light grey, slightly aggregated, and composed of crystalline grains. It dissolved completely in water, without colouring it, the solution giving, with muriatic acid, sulphuretted hydrogen, without producing any turbidness. It was scarcely affected by heat alone; but detonated with nitre, and raised to a white heat, afterwards diffused through water, and saturated with muriatic acid, it was found that the fluid contained no sulphuric acid, and but a very slight trace of barytes. Hence the re-conversion into sulphate had been complete. 120 parts of sulphate of baryta, in becoming sulphuret, lost 34 parts. This sulphuret is composed of

Barium	100
Sulphur . . .	24.47

Sulphuret of Strontium.—White, granulated, aggregated, and friable; 20 parts sulphate lost 7.2 parts by reduction into sulphuret; its composition is,

Strontium	100
Sulphur	36.6

Sulphuret of Calcium.—White and opaque, retaining the form of the gypsum used, soluble in water, &c., like the compound of barium; 20 parts of sulphate of lime from Puy, lost of water and oxygen 9.24. The sulphuret is composed of

Calcium	100
Sulphur	78.3

Sulphurets of Potassium and Sodium.—Mammilated, crystalline, translucid, and of a fine flesh-red colour. These dissolved in water, with great heat, are very difficult to roast; they do not evolve sulphur, but slowly become sulphates. When they have become mixed with charcoal in the crucible, they inflame upon being moistened. Sulphuret of potassium consists of,

Potassium	100
Sulphur	41.06

Sulphuret of sodium of,

Sodium	100
Sulphur	69.27

Sulphuret of Magnesium.—10 of sulphate of magnesia recently calcined, gave 3.95, of a white friable residue, which, boiled in water, gave a solution of hydro-sulphuret of magnesia, and pure magnesia remained; 1.5, acted on by water, gave a solution contain 0.18 magnesia; 1 heated with nitre, &c., gave 0.85 sulphate of baryta, equivalent to 0.12 sulphur. The sulphuret of magnesia is composed therefore of

		or by theory
Magnesium .	0.072	0.094
Sulphur . .	0.120	0.120
Magnesia . .	0.780	0.786
	972	1.000

To accord with the theory, the loss should have been 0.608, instead of 0.605.

Sulphuret of Copper.—10 of dry sulphate gave 4.76 of sulphuret, mixed with a few grains of metallic copper. M. Berthier ascertained that there was no action between this sulphuret and metallic copper; therefore, probably no sulphuret containing less sulphur exists.

Sulphuret of Zinc.—30 parts of sulphate gave, in one experiment, 4.5 parts; in another, 13.2. The sulphuret produced was of a flaxen colour, and in crystalline grains, composing a friable mass. When analyzed, it proved to be of the same composition as blende, *i.e.*,

Zinc	100
Sulphur	50

In the experiments on zinc an excessive loss occurred, which, after some trials, M. Berthier traced to the action of the charcoal on the sulphuret. He found that a piece of native blende thus heated, lost in two hours $\frac{7}{10}$ of its weight, and if powdered and mixed with charcoal, the whole would have been dissipated in a short time. This action is attributed to the affinity of the carbon for the sulphur; and it was ascertained, by heating a mixture of charcoal and sulphuret of antimony, that an analogous action took place, for the gaseous products being made to pass through a condenser, a considerable quantity of sulphuret of carbon was procured. Sulphuret of iron, of copper, and many other sulphurets, diminish in weight, when heated with charcoal, from the same cause.

Sulphate of Lead, with charcoal, gives a sub-sulphuret of lead, which, by further heat, is partly volatilized, and partly decomposed.

Sulphuret of Manganese is easily obtained. It is pulverulent, black, and without lustre, dissolving in muriatic acid, and liberating pure sulphuretted hydrogen. It is composed of

Manganese . .	100
Sulphur . . .	56.32

M. Berthier then enters into an account of various double sulphurets, which, though highly interesting, we have not room to notice at present.—*Journal des Mines*, vii. 421.

3. *On Compounds of Nickel, by J. L. Lassaigne.*—The object of M. Lassaigne was to ascertain directly the representative number of nickel, by experiments on its compounds. They were made, we presume, with perfectly pure nickel, obtained by M. Laugier's process; for the principal reason for their being undertaken, was the discovery by M. Laugier, that the nickel, generally considered as pure, contained a large proportion of cobalt.

Protoxide of Nickel.—A given weight of pure nickel was dissolved in pure nitric acid, evaporated to dryness, and decomposed by heat. It was of a gray colour, soluble in acids, precipitated by alkalis as a hydrate, &c. Composition,

Nickel	100
Oxygen	20

Deutoxide of Nickel.—Obtained by diffusing hydrate of nickel in water, and passing a current of chlorine through it; one part is dissolved, and the other converted into peroxide of nickel. It is of a brilliant black colour; heated, it loses oxygen and becomes protoxide. Acids dissolve it, liberating oxygen, except muriatic acid, which produces chlorine with it. Its composition was ascertained by its loss of weight when heated, and appeared to be,

Nickel . .	100	or rather by theory	100
Oxygen . .	39.44		40

Sulphuret of Nickel.—Prepared directly from its elements. It is of a yellow colour like iron pyrites, and very brittle. Insoluble in sulphuric and muriatic acid, but decomposed by nitro-muriatic acid. It was analyzed by calcination with nitre, and the sulphuric acid determined by barytes. It was composed of

Nickel . .	100	by theory	100
Sulphur . .	41.3		40

Chloride of Nickel.—Prepared by evaporating the muriate of nickel to dryness. The dry product is the protochloride of nickel; is of a yellow-green colour, and is composed of

Nickel	100
Chlorine	90

When the proto-chloride of nickel is calcined in a retort, one portion of an olive-green colour remains in the bottom of the vessel, whilst another sublimes and crystallizes in small light brilliant plates of a gold yellow colour. These are to be considered as a deuto-chloride of nickel, and are insoluble in water, and indecomposable by sulphuric acid. They are formed of

Nickel . .	100	by theory of	100
Chlorine .	200		180

Iodide of Nickel.—Obtained by heating nickel and iodine in a tube. It is a brown substance; fusible; soluble in water, colouring it of a light-green; and composed of

Nickel . .	100	by theory of	100
Iodine . .	320		312.5

Ann. de Chim. xxi. 255.

4. *On Indigo, Cerulin, Phenicin, &c., by Mr. Crum.*—The following is a very compressed account of some points on the chemical history of indigo, for which science is principally indebted to Mr. Crum. We have taken them from that gentleman's paper, published in the Annals of Philosophy.

Indigo may be obtained by agitating the yellow liquid of the dyer's blue vat in contact with air, and digesting the precipitate in dilute muriatic acid, and afterwards in alcohol. To obtain it perfectly pure it should be sublimed, which is best done by placing eight or ten grains of it in the cover of a platinum crucible, putting another cover over it, and then heating the lower by a lamp; a sublimate rises which is pure indigo. The apparatus must not be cooled during the sublimation. Sublimed indigo crystallizes in long flat needles, splitting into quadrangular prisms. Looked at in heaps, the colour is rich chestnut-brown; at a particular angle, they have an intense copper-colour, but thin plates when looked at directly before the light, are seen to be transparent, and of a beautiful blue colour. Indigo sublimes at 550°, and it melts and also decomposes very nearly at the same temperature. Its specific gravity is 1.35. It sublimes in open vessels leaving no residuum, but in close vessels a quantity of charcoal is deposited. Volatile and fixed oils dissolve small portions of it.

Being analyzed by oxide of copper, its composition appeared to be

1	atom azote	1.75	10.77
2	—— oxygen	2.00	12.31
4	—— hydrogen	0.50	3.08
16	—— carbon	12.00	73.84
		16.25	100

Excepting a minute proportion of lime, precipitated indigo gave the same result.

When indigo is digested in sulphuric acid, it is converted into a very peculiar blue substance, to which Mr. Crum has given the name of *cerulin.* The mixture requires much water to dissolve it, and its filtered solution is precipitated by potash. This precipitate is as plentiful before one-fourth of the acid is saturated as when the whole is neutralized; it is also produced by sulphate of potash. When thrown on a filter and washed, it entirely dissolved in pure water, but the presence of any salt of potash rendered it insoluble.

Some of the precipitate, washed first by weak solution of acetate of potash, and afterwards by alcohol, was burnt in a crucible; a large quantity of ashes was left, consisting of neutral sulphate of potash, with a little iron. Another portion of the substance, prepared even with muriatic acid and muriate of potash, gave sulphate of potash as before. Hence it appears to be a combination of cerulin with sulphate of potash, and may be called ceruleo-sulphate of potash. The salt forms more than a fourth of its weight.

A ceruleo-sulphate of soda may also be formed; it is more soluble than the compound with potash. Ceruleo-sulphate of ammonia is still more soluble, and is decomposed by potash or soda. The compound with barytes is extremely insoluble. An abundant blue precipitate is formed by muriate of barytes in solutions of ceruleo-sulphate of potash, containing so little sulphuric acid as not to be troubled in the slightest degree, if the cerulin be previously destroyed by nitric acid.

Ceruleo-sulphate of potash when moistened is almost black, when dry of a deep copper-colour—one part dissolves in 140 of water, forming an intense blue solution, which is precipitated by every thing but distilled water. Luminous objects seen through it appear of a rich scarlet-colour, but a single drop of nitrate or sulphate of copper added, makes them appear blue. Acid again makes them appear red.

With regard to the phenomena attending the production of cerulin, when indigo is put into sulphuric acid, it is dissolved, and a yellow fluid results, rendered blue by water. The blue precipitated is indigo unchanged; but if the yellow solution be left undiluted, it becomes blue of itself, and in less than 24 hours the whole becomes cerulin. Any production of sulphurous acid which may be observed, is due to impurities; for when pure, there is no action of that kind by the application of boiling-water heat for some hours. On analyzing the ceruleo-sulphate of potash by oxide of copper, cerulin was found to be composed of

1 atom azote	1.75	8.43
6 —— oxygen	6.00	28.92
8 —— hydrogen	1.00	4.82
16 —— carbon	12.00	57.83
	20.75	100.00

By stopping the action of the sulphuric acid on the indigo, before the formation of cerulin is complete, Mr. Crum obtained what he conceives to be a new and peculiar body, to which he has given the name of *phenicin*. As soon as the mixture of acid and indigo is become of a bottle-green colour, it is to be diluted with a large quantity of water, filtered and washed. The blue washings which will ultimately be obtained are to be precipitated by muriate of potash, and phenicin will be precipitated, of a beautiful reddish purple colour. It is to be filtered and washed, till the washing precipitates red with nitrate of silver; it may then be dried.

Phenicin forms blue solutions, both in water and alcohol, but all salts precipitate it purple. It appears to be easily changed into cerulin, by the mere action of water. From the mean of several experiments, 100 of indigo produces 120 of phenicin. Its composition is considered as being,

1 atom azote	1.75	9.46
4 —— oxygen	4.00	21.62
6 —— hydrogen	0.75	4.05
16 —— carbon	12.00	64.87
	18.5	100.00

Alcohol remarkably modifies the action of sulphuric acid upon indigo. Three parts of alcohol, sp. gr. 0.84, with two parts of acid, dissolves indigo without rendering it yellow, and it may remain thus any length of time, without change.

5. *Robiquet on Volatile Oil of Bitter Almonds.*—This oil, when exposed to the air for a few minutes, becomes a crystalline mass, and loses its odour. M. Vogel, who first remarked the fact, found that the odour was restored by dissolving the crystals in hydro-sulphuret of ammonia. He attributed the loss of odour and change of state to oxidation, and the restoration of odour by the hydro-sulphuret, as due to a deoxidation effected by that substance. M. Robiquet, on the contrary, led by his own particular views of aroma, (see Vol. x. p. 109,) attributed the loss of odour to the loss of ammonia; and its restoration, to the ammonia added in the hydro-sulphuret.

With a view to illustrate the true cause of the phenomena, M. Robiquet lately experimented on this subject. He found, that instead of taking place in a few minutes, the crystallization sometimes required several days; and, in consequence, he was led to distil the oil, collecting the results in different portions. In this way he found, that the first portions underwent no change in contact with the air, but that the last portions crystallized immediately on exposure to it, or to oxygen, with absorption of the gas; whilst in nitrogen, hydrogen, carbonic acid, or in the torricellian vacuum, no change took place.

By further examination, it was ascertained that the most volatile portion of the oil contained nitrogen, as an element; for when boiled with solution of potash, it gave prussiate of potash, and when heated with oxide of copper, nitrogen. The less volatile and crystallizable parts contained no nitrogen; and when pure and in crystals, it was found that the odour of bitter almonds was not given to them by hydro-sulphuret of ammonia. The crystalline matter appears to be an acid substance; it reddens litmus; it is soluble in boiling water, and crystallizes by cooling; it is fusible, and readily volatile; it unites to alkalies, and appears to have no analogy with the oil from which it is derived.

These two parts of the oil of bitter almonds, when examined as to their action on the animal economy, were found entirely different; the more volatile was excessively poisonous, but the crystallizable matter was quite inert. M. Robiquet, in considering the nature of the principle containing nitrogen, is inclined to consider it as different from prussic acid, though readily convertible into it. Fixed alkalies, for instance, exert no action on it when cold, though at high temperatures they readily form prussiates, and a crystalline substance very different from that already described. Another acid, and a resinous matter, is also found at the same time.

M. Robiquet, in a note, considers the oil of the cherry laurel as identical with that of bitter almonds.—*Ann. de Chim.* xxi. 250.

6. *Action of Animal Charcoal in the refining of Sugar.*—M. Payen proves, in a memoir which has been rewarded by the Pharmaceutical Society of Paris, 1st, That the decolouring power of charcoal, in general, depends on its state of division; 2d, That in the various charcoals, the carbonaceous matter, only, acts on the colouring matters, combining with and precipitating them; 3d, That in the application of charcoal to the refining of sugar, it acts also on the extractive matters, for it singularly favours the crystallization; 4th, That according to the above principles, the decolouring action of charcoals may be so modified, as to make the most inert become the most active; 5th, That the distinction between animal and vegetable charcoals is improper, and that for it may be substituted that of dull and brilliant charcoals; 6th, That of the substances present in charcoal besides carbon, and particularly in animal charcoal, those which favour the decolouring action have an influence relative only to the carbon: they serve as auxiliaries to it, by isolating its particles, and presenting them more freely to the action of the colouring matter; 7th, That animal charcoal, besides its decolouring power, has the property of taking lime in solution from water and syrup. 8th, That neither vegetables, or other charcoals besides animal, have the power of taking lime from water or syrup; 9th, That by the aid of an instrument, which he proposes to call a decolorimeter, it will be easy to appreciate exactly the decolouring power of all kinds of charcoal.—*Annales de Chim.* xxi. 215.

7. *Refining or toughening of Copper.*—When the smelter has reduced his copper perfectly, it is in what is called a dry state. It is brittle, of a deep red colour inclining to purple, an open grain, and a crystalline structure. A process is then resorted to, called the *poling*, the object being to render the copper tough and malleable. The metal, whilst in fusion in the reverberatory furnace, has its surface covered with charcoal, and

a pole, generally of birch, is thrust into it, and retained there; a violent ebullition takes place, which is continued until the refiner perceives, by the assays he takes, that the grain is closed and silky, and the metal of a light red colour. The copper is then laded out into cakes.

The whole of this operation requires great attention. The surface must be covered with charcoal, or the metal will go back. On the contrary, if the poling be continued too long, the colour becomes a light yellowish red, and the malleability is injured. In that case, by drawing the charcoal off, and exposing the metal to air, it is restored to a proper state.

Some curious questions arise with regard to the copper in these different states. Is the dry copper combined with oxygen? or is there any oxide of copper, either diffused through or combined with the metal? Is the overpoled copper a compound with carbon? Is the malleable metal, copper, in a pure state? or is the effect of the pole merely mechanical? It may be remarked, that dry copper has an extraordinary action on the iron tools used; they become bright, like iron in a smith's forge, and are consumed much more rapidly than when the copper is in a malleable state; also, that when copper is gone too far, it oxidizes slowly; on the surface it remains bright, and more than usually splendent, reflecting, like a mirror, every brick in the roof; thus supporting the idea, that carbon is united with it, and, by combining with the oxygen of the air, prevents the formation of oxide.—See Mr. Vivian's paper, *Ann. Phil.* v. 121.

On this head we may refer also to Mr. Lucas's experiments on silver. See *Journal*, Vol. viii. p. 168.

8. *Action of Ammoniacal Gas on Copper.*—The following experiments are by Signor Fusinieri:—Dry iron and copper wires were introduced into dry barometer tubes, into which dry ammoniacal gas was then introduced over mercury. Then inclining the tubes, the part containing the metal was heated by a lamp. After a while, the iron became of a brownish colour, and the volume of the gas increased, from the decomposition of the ammonia into its elements; but no other results were obtained.

On the contrary, the copper wire gave evident signs of combination. The bulk of the gas diminished, notwithstanding a partial decomposition, and consequent expansion. The copper became of a paler colour, and a sublimate rose, and attached itself to the tube, having the same colour as the copper, and, in one place, even its metallic splendour. The heat was continued for three quarters of an hour, during which time the matter in the tube remained unchanged. A copper wire thus heated being withdrawn from the tube, and moistened, became slightly blue after some time, and the sublimate in the tube underwent the same change slowly in the air. Another tube, with its copper contents left exposed to the air alone, became brown and blue in different parts.

Sig. Fusinieri deduces from these results, that dry ammoniacal gas combines with copper, by the aid of heat, the compound being volatile, and retains the colours of the metal, though it be more pale. Also, that the formation happens without the production of colours; and also, that this dry ammoniuret of copper has the power of decomposing water, of oxydizing the metal, and then of forming the common blue ammoniuret.—*Giornale di Fisica.*

These conclusions do not come with much force to our minds; but we insert the experiment at this time, because chemists are anxiously looking to nitrogen and its compounds for some results illustrative of its nature.—Ed.

9. *Estimation of Carbonic Acid in Mineral Waters.*—It is frequently an object in the analysis of mineral waters, to ascertain the quantity of carbonic acid in them; and for this, several processes are recommended. Among others, is that of boiling the water in a retort or flask, and passing the gas liberated from it through a solution of muriate of lime, or barytes to which ammonia has been added; the quantity of carbonate thrown down being the indication of the quantity of carbonic acid from the water.

Dr. Vogel of Munich, however, finds the process very faulty, from the circumstance of its not indicating small quantities. Three or four cubic inches of carbonic acid gas, added to one ounce of ammonia, and this to a solution of one part of muriate of baryta in nine of water, produced no change. Precipitation would begin only on adding more carbonic acid, or on boiling. An ammoniacal muriate of baryta, added to carbonic acid gas, over mercury, caused no precipitation, by the absorption of the first two or three inches of gas; and when the precipitate, caused by a further absorption of gas, had been filtered out from the liquid, more was obtained by ebullition. Only in cases where a great quantity of gas is absorbed by the ammoniacal solution of baryta or lime, or where the mixture stands for several days, are the carbonates entirely precipitated.

Even lime water, when the lime is not entirely separated by carbonic acid, retains some carbonate of lime in solution, which will be found by heating such lime water to ebullition in a closed retort, when the carbonate will fall to the bottom; and it was ascertained by a comparative experiment, that the precipitate was not due to the separation of lime from the hot water, but was really a carbonate of lime.

Though both lime-water and barytes water absorb carbonic acid, and readily deposit carbonates; yet, when previously mixed with ammonia, they are not in the least rendered turbid by a small quantity of carbonic acid gas, and ebullition is required to perfect the precipitation.

Lime-water acts in the same manner when poured into a solution of alkaline carbonate of ammonia; the transparency is slightly clouded, and immediately after restored, and ebullition is required to obtain a precipitate. If a large proportion of lime-water be added, a permanent precipitate is obtained.

If, therefore, a muriate of barytes, or lime mixed with ammonia, be employed to detect carbonic acid, it must be boiled some time, to throw down the whole of the precipitate; but Dr. Vogel recommends, as the surest means to pass the gas through barytic water, and to determine the volume of the carbonic acid gas, from the weight of the carbonate, when dried.

It is often of importance to obtain the carbonic acid from the water at the spring head. To do this, we have sometimes adopted the plan of adding such a quantity of barytes water to a given volume of the spring water, as to precipitate all the carbonic acid, and then ascertain the quantity of carbonic acid in the precipitate in the laboratory, and we know of no objections to the plan.—Ed.

10. *Plumbago in Coal-gas Retorts.*—The following description of an artificial plumbago, is by the Rev. J. J. Conybeare; he is speaking of the retorts in the Bath gas-works. The unservicable retorts, on being withdrawn from their beds, are found lined with a coating of plumbago, averaging the thickness of four inches. This coating is thickest towards the bottom of the retort. The general aspect of the predominant va-

riety may be thus described: *Colour* iron-grey, somewhat lighter than that of native plumbago; *texture* scaly; *structure* mamellated, usually in very close aggregation—some specimens exhibit this structure on the large scale, but generally it requires the lens to be seen; *hardness* variable, but always greater than the best native plumbago—scratches gypsum, but is scratched by calc spar; *lustre* of the exterior surface sometimes very considerable, *lustre* of the fracture usually but small; the powder uniformly resembles that of common plumbago, but is somewhat less brilliant. The quantity of iron in it seldom appeared to amount to 9 per cent. It is hardly fit for finer purposes of art, but it is proposed to use it in diminishing friction, in making crucibles, furnaces, &c.—*Ann. Phil.* v. 51.

The artificial production of plumbago is by no means an unusual event. See p. 321, Vol. IX. of this Journal. In fine, iron castings where charcoal in fine powder has been used as the facing, the cast may be observed every where covered with a thin coat of plumbago.—Ed.

11. *Test of the Dryness of Air or Gases.*—M. Serullas recommends the alloy of bismuth and potassium, obtained by heating together 60 parts carbonized cream of tartar, 120 of bismuth, and 1 of nitre, for two hours, as an excellent test of the dryness of gas in certain circumstances. A small fragment of the alloy is to be introduced into the gas over mercury, and the least moisture in it will tarnish the metal immediately. The alloy is so rich in potassium, that the smallest fragment, when cut with scissors, scintillates. If a piece be bruised, it burns, leaving a green oxide.

12. *Variation of Thermometers.*—Il Signor Bellani refers to the following experiment as a proof of the changeableness of a thermometer, with regard to the temperatures it expresses, and in illustration of the cause of those changes. Take a mercurial thermometer, including a range at least from freezing to boiling water, having degrees of such magnitude, that $\frac{1}{10}$ of a degree may readily be perceived, and not having been exposed for some months to a temperature near that of boiling water. Mark exactly the point at which the mercury stands in thawing ice, then plunge the bulb in boiling water, and then again mark the temperature indicated in thawing ice; it will indicate above a tenth of a degree lower this time than the former.

The effect is greater the higher the temperature is raised, and the more rapidly it is done; and M. Bellani attributes it to the slower contraction of the glass, after having been expanded by heat, as compared with that of the mercury. He refers to it as an unavoidable source of error in all delicate thermometrical operations, as in the barometrical thermometer, &c.

13. *Blue Iris Test Colour.*—Professor Ormstead of North Carolina University, recommends the tincture of the petals of the garden iris, or blue lily, as superior to every other test liquor known. It is reddened as litmus is, by blowing through it, or by a stream of carbonic acid gas. It is more convenient than violets, from the abundance of colouring matter contained in the petals; and it is said to be superior to red cabbage tincture, as well for its permanency as its delicacy. Of the former cause of superiority there may be doubts. This application of the petals of the blue iris has long been known to us; by rubbing them upon paper, we form a very convenient test either for acids or alkalies.

14. *Succinic Acid in Turpentine.*—MM. Lecanu and Serbat have ascertained with certainty the presence of succinic acid in turpentine. It rises when the oil is distilled, towards the end of the operation, and has all the properties of true succinic acid. They have pointed out also, that the presence of acetic acid takes from succinic acid the power of forming precipitates, with preparations of iron, copper, lead, or barytes. Neither will a mixture of acetate and succinate of potash precipitate these substances; on the contrary, the succinates, when produced, are soluble without difficulty, in a sufficient quantity of acetate of potash.—*Annales de Chim.* xxi. 328.

15. *Cinnabar.*—M. Kirchoff prepares cinnabar in the following manner. Triturate in a porcelain cup with a glass pestle 300 parts of mercury with 68 of sulphur moistened with some drops of a solution of potash till a black proto-sulphuret is formed, and then add 160 parts of potash, dissolved in an equal quantity of water. Heat the vessel containing the mixture over the flame of a candle or lamp, continuing the trituration without intermission. Add pure water from time to time as the liquid evaporates, that the substance may be constantly covered an inch deep. After two hours continued trituration,

a great part of the liquid being allowed to evaporate, the mixture begins to change from black to brown, and then quickly to red. No more water is to be added, but the trituration is to be continued. The mass will acquire the consistence of a jelly, and the red becomes more and more brilliant with great rapidity. When it has attained its highest perfection the cup should instantly be removed from the flame, or the red will quickly change to a dirty brown colour.—*Phil. Mag.*

16. *Dobereiner's Apparatus for making Extracts.*—This apparatus serves to extract by means of water, alcohol or ether, the soluble substances from any substance to be analyzed, in quantities from 10 up to 200 grains. It is composed of a tube of glass from 4 to 9 lines in diameter, and from 4 to 9 inches long. The tube is closed below by a cork, to which is adapted a small tube open at both ends. This, except that its upper extremity is covered with a piece of muslin, communicates with the large tube. The substance to be operated upon is put into the large tube about half filling it, and the solvent is then put in over it. A small glass bulb proportionate in size to the quantity of solvent used, is then emptied of air by heating a few drops of alcohol in it, and immediately attached by a tight cork to the lower end of the small tube. The whole apparatus is then set aside in a cool place; as the alcohol vapour condenses, a vacuum is produced, and the pressure of the air in the large tube forces the fluid through the substance to be operated upon into the bulb. In a few minutes the extraction is complete, the bulb is then removed, its contents taken out, the air in it again displaced, and the operation repeated; or, if necessary, the fluid is left in contact with the substance some time before it is made to pass from it into the bulb.—*Bib. Univ.* xxi. 188.

17. *Heat from Friction of a Solid and Fluid.*—It may be remarked that the rapid rotation of the little mills which complete the attenuation of the liquid mixture for paper before it passes to the tub, produces in it a very sensible heat not at all due to the elevation of the temperature of the wheel itself by the friction of its axis, for it cannot be perceived by touching that part, but attributable to the blow of the fans of the wheel on the mixture, which they strike with much rapidity and vio-

lence. This is the first instance known to us of heat produced by friction of a solid against a liquid. M. Pictet.—*Bib. Univ.* xxi. 134.

18. *Condensation of Gases into Liquids.*—In a note annexed to Mr. Faraday's paper, (page 74 of this Number,) we have mentioned the result of some experiments made by him in the laboratory of the Royal Institution, and which led to obtaining chlorine and muriatic acid in the liquid form. By pursuing this mode of experimenting, sulphuretted hydrogen, sulphurous acid, carbonic acid, cyanogen, euchlorine, and nitrous oxide, have been also found to assume the liquid form under pressure, and to appear as limpid and highly mobile fluids. It is probable that other gases may be condensed by similar means, and that nitrogen, oxygen, and even hydrogen itself may yield, provided sufficient pressure can be commanded. Some of Mr. Perkins's experiments render it more than probable that atmospheric air under a pressure of some hundred atmospheres changes its form; and it is not unlikely, that some very curious and interesting results may be obtained by the aid of a slight modification of the apparatus used by that gentleman in his researches connected with high pressure steam.

19. *Electricity of a Cat.*—The electricity excited upon rubbing the back of a cat is well known, and that it is rendered evident by snapping noise and sparks of light. Mr. Glover, in a letter to the editor of the Philosophical Magazine, describes so intense an action of this kind, as to enable the animal to give a very sensible electrical shock. This effect was obtained at pleasure by Mr. Glover, and also by some friends. When the cat was sitting on the lap of the person, if the left hand were placed under the throat with the middle finger and the thumb gently pressing the bones of the animal's shoulder, and the right hand were passed along the back, shocks were felt in the left hand; and when the right hand was placed under the throat, whilst the left hand rubbed the back, the shocks were felt in the right hand. When the atmosphere has been favourable, and the cat had lain some time before the fire, the experiment always succeeded.—*Phil. Mag.* lx. 467.

20. *Magnetism of Solar Rays.*—The Royal Academy of Sciences, at Lyons, have offered a prize of 300 francs, for an

essay on the following subject. To shew by decisive experiments if the violet ray of the solar spectrum possesses the virtue of communicating magnetism to the unmagnetized needle of steel; if this virtue belongs to it, to the exclusion of the other coloured rays—and, in short, if this species of communicated magnetism, attributed to the violet light, is real or illusory. It is stated, that Professor Configliachi, found magnetism was communicated by every other ray of light.—Mémoires to be sent to MM. Mollet and Dumas, before July, 1823.

21. *Inflammation of Powder under Water.*—M. Serullas has given the following directions for the preparation of a very fulminating charcoal, by means of which, gunpowder may very readily be inflamed under water.

Carefully powder together 100 parts of tartar emetic, and 3 parts of lamp black, or common charcoal. Prepare some crucibles, capable each of holding about 2 ounces of the mixture, by rubbing them within with powdered charcoal to prevent the adherence of the carbonaceous mass left after calcination. Fill them about three-fourths with the mixture, then put in a stratum of powdered charcoal, and lute on a cover; after 3 hours' calcination in a good reverberatory furnace, the crucibles are to be removed, and left for six or seven hours to cool, that the air, which always enters, may have time to burn the surface of the fulminating mass, for otherwise, if withdrawn too soon, explosion always takes place. At the end of that time great care is to be taken in transferring the mass in the crucible as rapidly as possible into a vessel with a large aperture, which can be perfectly closed. In time, the mass divides of itself into fragments, and may be preserved for years.

When the calcination has been thus performed, the produce is excessively fulminating; so as, without compression or confinement, to give, on the contact of water, a detonation like that of a powerful musket.

The following mixture will also produce an equally fulminating charcoal; 100 parts of antimony, 75 of cream of tartar, 12 of lamp black, well powdered and mixed together.

The experiment of firing gunpowder under water by means of these substances, was made in the following manner:—half an ounce of gunpowder was put into a strong glass tube, closed at one end; a piece of fulminating charcoal, about the size of a pea, was placed upon it, and immediately the orifice of the tube closed by a prepared cork, which had a small hole through it, closed by fat lute. The tube was then retained by weights at a depth of between two and three feet beneath the water, and then, by means of a steel wire fixed to a long rod, the lute was perforated, and water admitted. The powder immediately inflamed, and a weight of above 2lb. was thrown out of the vessel containing the water.—*Annales de Chim.* xxi. 197.

III. NATURAL HISTORY.

1. *On the Ascent of Clouds in the Atmosphere, by M. Fresnel.*—Among the causes which most effectually contribute to the ascent of clouds in the atmosphere, there is one to which little attention has been given, but without which it appears impossible to give a satisfactory explanation of the phenomenon. It is independent of the constitution of the globules of water, or vesicular vapour composing the cloud; and is equally applicable to one formed of an assemblage of delicate crystals, such as may actually exist in the high regions of the atmosphere.

Air, as well as other colourless gases, permits the solar rays to pass without being heated by them; and to heat them, the contact of a solid or liquid body, heated by the same ray, is required. Consider, then, the case of a cloud formed of minute globules of water, or very fine crystals of snow: from the extreme division of the water, a very multiplied contact with the air is obtained, and the water being susceptible of an increase of temperature from the solar and terrestrial rays, the air within the cloud, and near to its surface, will become more dilated than the neighbouring air, and consequently lighter. It equally results from the hypothesis, on the extreme division of the matter of the cloud, that the particles which compose it may be very near each other, so as to leave but small intervals, and nevertheless be very much smaller than the intervals; so that the whole weight of the water in the cloud should be but a a small fraction of the weight of the air containing it, and so small, that the difference between the density of the air in the cloud and the neighbouring air should more than compensate it. When the weight of the water and air containing it is less than that of an equal bulk of the surrounding air, it will ascend until it arrives at a region where these two weights are equal; and this height will depend on the fineness of the particles of the cloud, and the intervals which separate them.

The hot and dilated air contained in those intervals not being hermetically retained, will gradually escape; but this renewal of the internal air must take place very slowly, so that the temperature of the cloud will always be above that of the neighbouring air, and this ascending current of air, by the mere friction of its parts against the particles of the cloud, will tend to raise it, and that with the more energy as it is more rapid.

During the night the cloud is deprived of the solar rays, and its temperature should diminish, but it will still receive warm rays from the earth; and if it is very thick, or of great depth, its temperature can diminish only slowly. Experience proves directly, that clouds during the night are warmer than the air surrounding them, inasmuch as they send us more calorific rays. Supposing even that the difference of temperature was much less by night than by day, still the clouds should descend with extreme slowness after sunset, because of their immense extent of surface, relative to their weight: it is a cause which, without referring to their elevation, must contribute powerfully to their suspension, and the rise of the sun would again elevate them to their former altitude, if winds or other atmospheric phenomena have not changed the conditions of equilibrium. Such an effect may be produced by an augmentation or diminution of the particles of the cloud, or the intervals between them; and the changes in the temperature of the surrounding air, alter the conditions of equilibrium, and consequently the height to which the cloud may rise. There are without doubt, also, other causes which contribute to the elevation and suspension of clouds, as the ascending currents spoken of by M. Gay Lussac (vol. xiv. p. 446). I do not purpose to consider all the causes, but merely to indicate that which appears to me the most important.—*Bib. Univ.* xxi. 255.

2. *Aërolite of Epinal.*—The stone which fell in the neighbourhood of Epinal, about three quarters of a league from La Baffe, on the 15th of last September, has been examined chemically by M. Vauquelin. Like most aërolites, it was covered by a fused black coat. Within, it was of a gray colour, with many metallic points. Ground in a mortar, a great number of particles of metallic iron were separated, leaving an impalpable earthy powder.

From the quantity of metallic iron existing in this stone, it was difficult to obtain a portion for analysis, which should give the true composition of the whole: 4 grammes, (61.8 gr.) were taken and gave,

Silica, ...	1.40
Oxide of iron, . . .	2.51
Sulphur, ...	.09
Oxide of chrome . .	.01
Oxide of nickel, . .	.02
Magnesia, ...	.17
Lime and potassa . .	.50
	4.70

The 2.51 oxide of iron correspond to 1.76 metallic iron; but the 0.09 of sulphur would require 0.16 of iron to form the protosulphuret; and if, beside this, 0.18 be subtracted for the 0.25 of oxide of iron, which in the analysis was found united to the chromic acid, there will remain 1.42 of metallic iron, containing only nickel and manganese for the 4 of aërolite. The quantity of nickel was so small, that cobalt could not be looked for in it, but M. Vauquelin thinks it probable that it was present.—*Ann. de Chim.* xxi. 324.

3. *Large Meteor.*—A magnificent meteor was seen by Mr. Davenport, on the 28th October last, at about half-past five in the evening. It was seen from Silver-hill, on the Hastings road, and appeared as a luminous ball, of full one-third of the apparent diameter of the moon, giving a remarkably bright and white light. Its direction was north-east, its height above the horizon about 22°. It passed horizontally to the west, over an arc of about 20°, occupying about 8¼ seconds of time. Mr. Davenport is anxious to know whether other persons have seen the same meteor; and if so, from whence, and in what direction.—*Ann. Phil.*

4. *Fall of Rain in the Tropics.*—Professor Silliman gives the following statement, on the authority of M. Rousuis, captain of a vessel. It is contained in a letter from Cayenne. "You will perhaps learn, with no inconsiderable interest, the following meteorological fact, the authenticity of which I am able to certify. From the 1st to the 24th of January (1820), there fell upon the island of Cayenne, twelve feet seven inches of water. This observation was made by a person of the highest veracity, and I assured myself, by exposing a vessel in the middle of my yard, that there fell in the city ten and a quarter inches of water,

between eight in the evening and six in the morning of the 14th and 15th of that month."

5. *New Comet.*—A luminous appearance was observed in the heavens, on the night of Wednesday, Nov. 13, at the distance of about a degree and a half from Cor Caroli, which very much resembled a small comet. It was viewed distinctly for ten minutes, from the hills in the neighbourhood of East Grinstead, but a veil of cloud then hid it, and it has not since been seen. —*New Monthly Mag.* ix. 33.

6. *Analysis of Uranite.*—This mineral has been analyzed, both by Mr. Gregor and Berzelius; the latter philosopher found it to be "a compound of oxide of uranium with lime and water; in fact, a true salt, with a base of lime, in which the oxide acts as an acid;" and he considers the Cornish variety as containing an accidental admixture of arseniate of copper.

Mr. Phillips has lately re-analyzed this mineral, and very unexpectedly finds it to contain phosphoric acid; indeed, to be a phosphate. A specimen from Cornwall gave,

Silica	0.5
Phosphoric acid . .	16.0
Oxide of uranium . .	60.0
Oxide of copper . .	9.0
Water	14.5
	100

or, neglecting the silica,

Phosphate of uranium	73.2
Phosphate of copper .	12.3
Water	14.5

Ann. Phil., v. 59.

7. *Native Phosphate of Alumina.*—A substance has lately been placed in the hands of M. Vauquelin for analysis, which proved to be phosphate of alumina. It was brought by M. Debassyns from the Quartier Saint Paul, Isle Bourbon, being found in a volcanic cavern, occurring in a large basin, formed by the river Saint Gilles, and known in the country by the name of the Blue Basin.

No one had before entered the cavern, which is very deep and irregular, and covered with stalactites. After a few steps, there are found considerable portions of the white earth, deposited against the sides; and it occurs in proceeding, until replaced by a black earth, which, in certain places, forms the entire bottom of the cavern, and preserves the form of the blocks of lava, which appear to have fallen from the roof.

The white earth has a slight tint of yellow, no consistence, and is very light; it feels unctuous, and adheres to the tongue. On analysis, it proved to be a subphosphate of alumina, mixed with a small quantity of phosphate of ammonia.

1.400	Alumina.
0.914	Phosphoric acid.
0.094	Ammonia.
	Water.

The black matter found in the cavern was almost entirely animal; five parts gave only 0.35 of ashes when burnt, which were phosphate and carbonate of lime, with a little iron. In the same cavern were found heaps of bones, which, from a specimen brought home, appeared very ancient. The specimen was very fragile, and was covered with crystals, in brilliant needles, which proved to be phosphate of lime. M. Vauquelin suggests that this animal matter was the source of the phosphoric acid, found united with the alumina.

8. *Crystallized Stalactitic Quartz.*—The stalactites which covered the roof of this cavern, when examined by M. Vauquelin, proved to be quartz. They were found in concentric layers, and offered all the physical characters of calcareous stalactites, except the hardness. The composition was,

Silex	.850
Oxide iron . .	.060
Lime	.031
Water	.150
Loss	.009
	1.100

Ann. de Chim. xxi. 188.

9. *Ammonia in Lava.*—Professor Gmelin, of Tubingen, is said to have discovered, in clink-stone lava, ammonia, which is disengaged by distillation. He also found it in columnar basalt.

10. *Muriate of Ammonia from Coal Strata.*—There is a coal-mine near Saint Etienne, which, having been fired, through in-

advertence, has now been burning for several years. Besides the usual products arising from the combustion of coal, it exhales a great quantity of muriate of ammonia. Fumes arise from the burning surface of the ground, which condense into the solid salt, and in dry weather the whole surface is covered with it. Some very fine specimens were found within an inhabited house; and so abundant was the production in the years 1818 and 1819, that many pieces were separated from the walls, weighing above 2 lbs. avoirdupois. The ruins of this house, treated in the large way for the separation of the salt from them, gave such results as would have proved lucrative, if pursued.

In referring to the probable source of this salt, it is remarked, that the water of all the wells on this coal stratum contain, among other salts, a very notable quantity of earthy muriates.—*Ann. de Chim.* xxi. 158.

11. *Waters of Carlsbad.*—The waters of Carlsbad, taken from the principal source, have been analyzed lately by M. Berzelius, who finds many substances in them not hitherto suspected. The following are his most extraordinary results: 1000 parts of water gave,

Sulphate of soda	2.58714
Carbonate of soda	1.25200
Muriate of soda	1.04893
Carbonate of lime	0.31219
Fluate of lime	0.00331
Phosphate of lime	0.00019
Carbonate of strontian	0.00097
Carbonate of magnesia	0.18221
Phosphate of alumina	0.00034
Carbonate of iron	0.00424
Carbonate of manganese	traces
Silica	0.07504
	5.46656

Ann. de Chim. xxi. 248.

12. *On the Flowers of the Meadow Saffron, by Mr. Frost.*—This last autumn, I made several preparations of the meadow saffron flower (*viz.*, a vinegar tincture and wine), which have subsequently been administered by several able physicians with whom I am acquainted; and they have informed me that the preparations of the flowers operate more uniformly and certainly

than those of the bulb and seeds. It has long been a matter of great doubt as to what the basis of the celebrated *Eau Medicinale* really is, but it is now pretty certain that a tincture of the flowers of *colchicum autumnale* constitutes that noted nostrum.

13. *Return of Captain Laing from the Solima Territory, in Africa.* We are happy to have it in our power to state, that Capt. Laing, of the Royal African Colonial Regiment, to whom the readers of the *Quarterly Journal* are indebted for the narrative of Mahomed Misrah's Journey from Egypt to the Western Coast of Africa, published in our XXVIIth Number, has returned to Sierra Leone, from a residence of some months in the Solima territory, to which he proceeded in April last, by permission of Sir Charles Macarthy, and on the invitation of the King.

The country, thus visited for the first time by an European, possesses a peculiar geographical interest, as the source of the mysterious Niger: we understand that the elevation above the sea, as well as the latitude and longitude of the hill of Soma, from whence it derives its origin, have been satisfactorily ascertained by Captain Laing, and that his observations and journal are on their way to England.

The information which Captain Laing has obtained, cannot fail in other respects also to be both important and interesting, as the Solimas are a numerous and powerful nation of the interior, of whom scarcely more than the name was known until three years ago, when an army of 10,000 men appeared in the Mandingo country, to terminate a dispute between two chiefs of that nation, the weaker of whom had appealed to the King of Solima; it was upon this occasion that Captain (then Lieutenant) Laing was despatched by the government of Sierra Leone on a mission to Yaradee, brother of the king, and commanding the army, whose confidence and good opinion he succeeded in gaining, which led to the present visit.

We are happy to learn that Captain Laing's health has been improved by travelling in the interior, which has hitherto been deemed so dangerous to Europeans; and that his further experience has confirmed the belief which he expressed in the communication to which we have referred, that no material difficulty would be experienced in the route from Sierra Leone, through Sankara, to the Niger at Nafi.

14. *Hauy's Collection of Minerals.*—The very complete mineral collection of the celebrated M. Hauy will shortly be sold at Paris by public auction. The professor, in his lifetime, refused for it an offer of 600,000 francs (24,000*l.* sterling).

15. *Organic Remains.*—The skeleton of a rhinoceros was discovered a short time ago, by some miners in search of lead ore, ninety feet below the surface of the earth, in the neighbourhood of Wirksworth, Derbyshire. The bones are in a perfect state, and the enamel of the teeth uninjured. We believe Mr. Buckland has seen these remains.

16. *Change of Water at Falls.*—In an account of the great water-falls of Renah, on the rivers Mohanuddy, Behur, and Jouse, in the province of Gund-wana, the writer describes the following phenomenon. The water, when it reaches the bottom of the fall, assumes a dirty green appearance, similar to salt water near the shore, and the taste becomes bad and sour. It is not the great depth of the pools into which the water falls that causes the colour; for that which issues out of the basins, and runs over rocks so shallow as not to come much above the ancle, has the same green aspect. The same effect is produced at each of the falls.—*Edinburgh Journal*, viii. 37.

17. *New Species of Fungi.*—Messrs. Pictet and Decandolle, whilst examining a paper manufactory, remarked the production of a great variety of fungi in the mass of rags placed together for the purpose of fermentation, previous to their being beaten into pulp. They were of various forms, sizes, and colours, and many of them appeared to M. Decandolle, who made a large collection of them, to be of undescribed species. It may be necessary to observe, that the fermentation was going on in a place under ground, and it is well known how much plants alter their external appearance when vegetating in such situations.

18. *Preservation of Echini, Asteriæ, Crabs, &c.*—It is a great object to preserve specimens of these species of animals in a natural history collection, so that they shall not fall to pieces. Colonel Mathieu, who has made a fine collection from the Isle of France, endeavoured to find some means of so drying the mucilaginous or membranous part, which serves as an

articulation between the joints, as to prevent that separation which so frequently takes place; and he found the best to be the application of dilute lime-water, before drying. Echini were first emptied, and then the animal put into lime-water for 12 hours, taken out and dried in the shade, and put in the same water for two hours, and then dried, the spines being preserved in their place by cotton.

Asteriæ were put alive into lime-water, and treated as the echini. Such as were fleshy had the flesh first removed. There are some so delicate as not to be able to bear immersion until dead; when alive, even fresh water will cause them to separate into many pieces.

With the crustaceous animals, as the crab, the head is first removed and dried in the shade, then the body and limbs emptied as much as possible. The specimen is then placed in lime-water five or six hours, and dried in the shade thrice successively. When dry, and having but little odour, the head is replaced, and the whole preserved in the shade. The colours are very little injured by the operation.—*Journ. de Physique*, xcv. 155.

19. *African Geography.*—Mr. Bowdich has made arrangements for the speedy publication of a sketch of the Portuguese establishments in Congo, Angola, and Benguela, with some account of the modern discoveries of the Portuguese in the interior of Angola and Mozambique, with a map of the coast and interior.

Art. XIX.—METEOROLOGICAL DIARY for the Months of December, 1822, and January and February, 1823, kept at Earl Spencer's Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For December, 1822.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Sunday	1	35	48	29.12	28.80	SSW	SW
Monday	2	34	40	28.88	28.90	WbS	SW
Tuesday	3	31	39	29.10	29.30	NE	W
Wednesday	4	28	44	29.40	29.24	WbS	NW
Thursday	5	29	45	29.54	29.28	WbS	SW
Friday	6	33	43	29.24	29.41	W	W
Saturday	7	31	38.5	29.70	29.79	W	WSW
Sunday	8	27	39	30.00	29.98	SE	SW
Monday	9	36	47	29.90	29.87	SW	SW
Tuesday	10	32	37	30.18	30.30	W	W
Wednesday	11	22	30	30.39	30.40	SW	ESE
Thursday	12	23	36	30.45	30.40	E	E
Friday	13	28	37	30.24	30.21	E	E
Saturday	14	33	34	30.06	30.06	SE	ESE
Sunday	15	21	31	29.96	29.92	SE	ESE
Monday	16	28	30	29.92	30.10	NE	SW
Tuesday	17	26	35	30.20	30.15	SW	W
Wednesday	18	36	45	30.12	30.12	NE	ENE
Thursday	19	33	38	30.18	30.23	NE	NE
Friday	20	27	32	30.28	30.28	E	EbN
Saturday	21	23.5	33	30.28	30.25	E	E
Sunday	22	23	36	30.08	30.00	ENE	NE
Monday	23	34	41	29.94	29.99	E	NE
Tuesday	24	34.5	36	29.91	30.10	E	E
Wednesday	25	32	35	30.25	30.38	E	E
Thursday	26	26	34.5	30.38	30.38	E	E
Friday	27	21.5	34	30.38	30.28	E	E
Saturday	28	23	31	30.20	30 12	ESE	E
Sunday	29	19	31	30.04	29.90	E	E
Monday	30	22	29.5	29.79	29.72	E	E
Tuesday	31	20.5	30	29.64	29.64	E	E

For January, 1823.

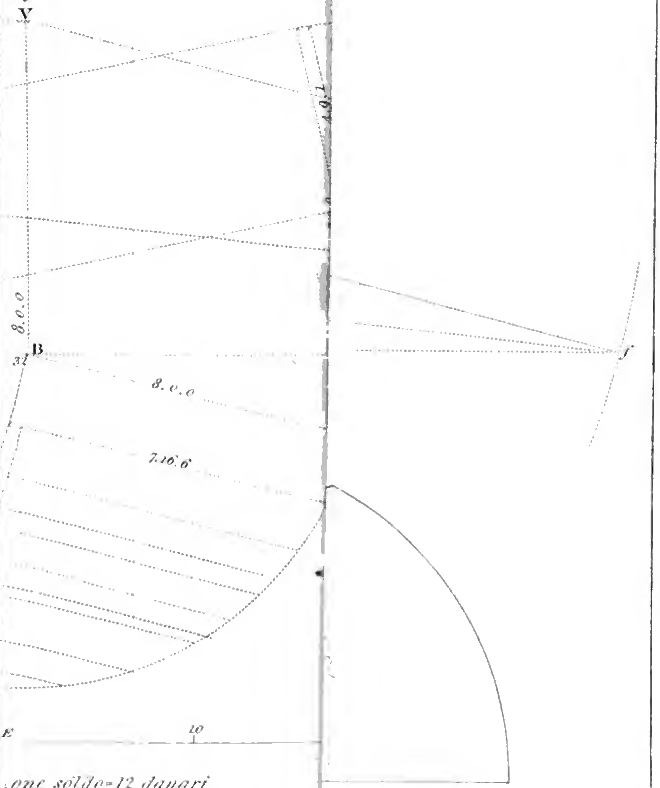
		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Wednesday	1	27.5	31.5	29.64	29.60	SE	W
Thursday	2	29	39	29.60	29.70	ESE	SE
Friday	3	38	42.5	29.70	29.70	SE	SE
Saturday	4	39	41	29.67	29.65	SE	SE
Sunday	5	35	37	29.67	29.67	EbS	SE
Monday	6	34	44	29.67	29.89	SE	SE
Tuesday	7	37	38	30.03	30.08	NE	NE
Wednesday	8	33	35.5	30.10	30.08	NE	E
Thursday	9	27.5	33	29.95	29.87	E	NE
Friday	10	21.5	32	29.83	29.83	NE	NE
Saturday	11	26.5	32	29.83	29.90	EbN	NE
Sunday	12	24	29	29.90	29.80	E	E
Monday	13	26	31.5	29.63	29.57	WbN	W
Tuesday	14	20	29	29.50	29.50	E	E
Wednesday	15	19	28.5	29.33	29.30	NE	NW
Thursday	16	26	32	29.31	29.31	WNW	NW
Friday	17	28	32.5	29.31	29.31	NW	W
Saturday	18	22	29	29.33	29.33	W	WbN
Sunday	19	3.5	21	29.40	29.47	NE	N
Monday	20	3	32	29.60	29.65	NW	E
Tuesday	21	30	33	29.77	29.79	EbN	NE
Wednesday	22	24	26	29.81	29.83	E	E
Thursday	23	44	22.5	29.78	29.65	E	EbN
Friday	24	17.5	28	29.67	29.78	E	EbN
Saturday	25	20	24	29.71	29.64	E	E
Sunday	26	16	30	29.73	29.70	ESE	SW
Monday	27	24.5	33	29.63	29.38	SbE	SE
Tuesday	28	33	43	29 30	29.28	SE	SE
Wednesday	29	43	48	29.02	28.97	S	S
Thursday	30	38	45	29.30	29.30	WbS	WbS
Friday	31	38	42	29.17	29.00	E	SE

For February, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Saturday	1	33	35	28.80	28.73	EbN	NE
Sunday	2	34	38	28.60	28.61	NE	NE
Monday	3	26	40	28.87	28.98	NE	W
Tuesday	4	31	38	29.17	29.27	W	W
Wednesday	5	27	33	29.60	29.67	NW	N
Thursday	6	28	31	29.57	29.39	ENE	ENE
Friday	7	28.5	35	29.13	29.08	E	E
Saturday	8	32.5	39.5	29.31	29.38	W	WSW
Sunday	9	33	41	29.51	29.51	WbS	SW
Monday	10	34	44	29.30	29.18	WbS	NW
Tuesday	11	33	51	29.27	29.23	S	SW
Wednesday	12	43	48	29.20	29.20	SW	SW
Thursday	13	31	44	29.34	29.50	SW	S
Friday	14	36	44	29.21	29.39	SSW	SW
Saturday	15	35.5	40	29.78	29.80	NW	SW
Sunday	16	35	39	30.07	30.12	EbN	NE
Monday	17	33	36	30.10	29.88	NE	SE
Tuesday	18	32	39	29.60	29.27	SE	SSE
Wednesday	19	38	50	28.97	29.30	SW	W
Thursday	20	30.5	42	29.60	29.77	W	WbS
Friday	21	37	49	29.38	29.20	SSE	W
Saturday	22	37	45	29.33	29.32	SW	W
Sunday	23	35	46	29.48	29.10	SW	WbS
Monday	24	40	48	29.27	29.53	W	NW
Tuesday	25	33	47	29.53	28.97	SW	SW
Wednesday	26	32	44	28.97	28.89	WSW	W
Thursday	27	32	41.5	28.97	29.08	N	NW
Friday	28	32.5	42	29.28	29.40	NW	NW

Plate I. Vol. XV.

Fig. 1.



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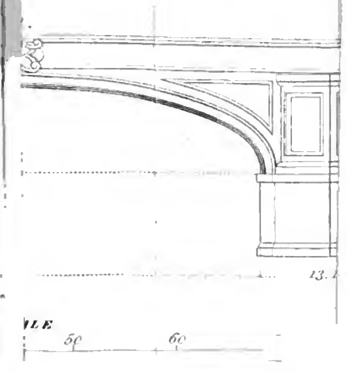

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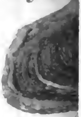

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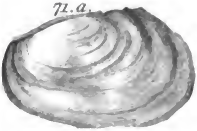

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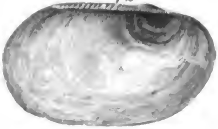

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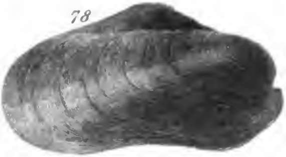

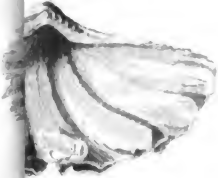

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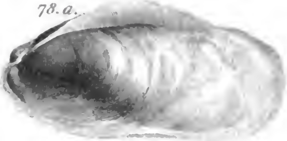

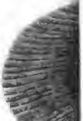

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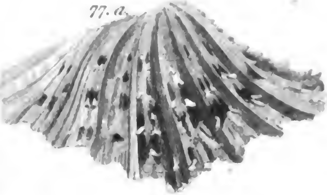

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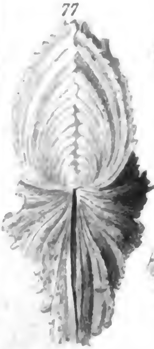

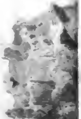

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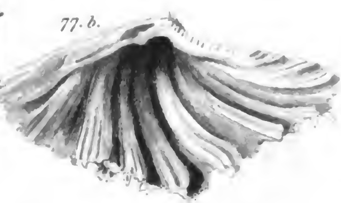

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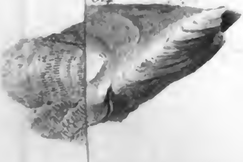

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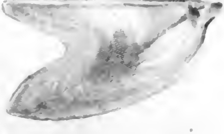

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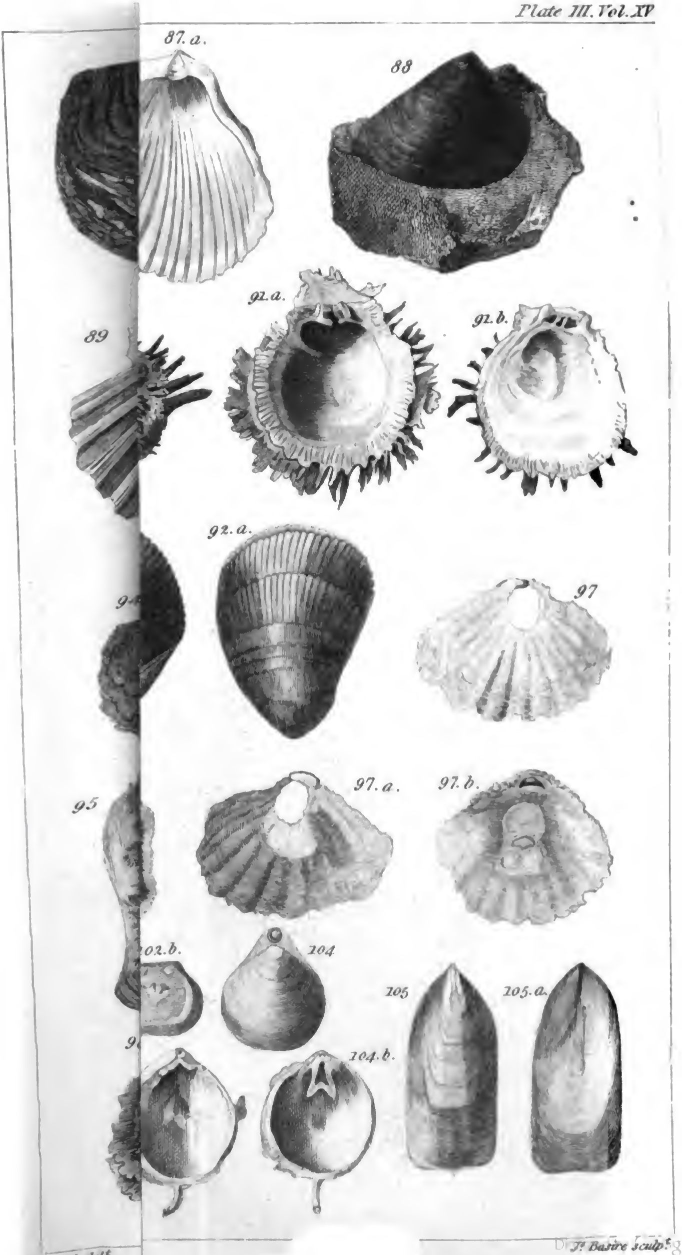
Plate III. Vol. XV.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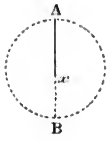
A. C. del.t

J.s Basire sculp.t

Fig. 1.



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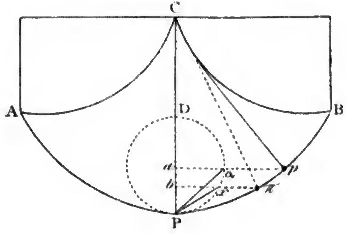
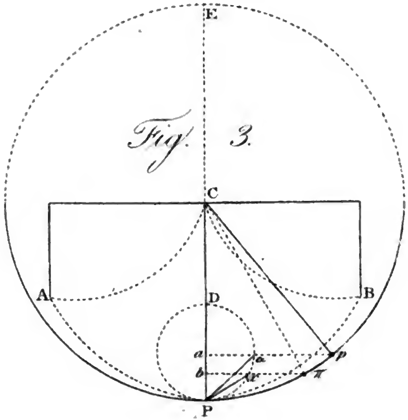


Fig. 3.



Js. Basire

Street London 1818

THE

QUARTERLY JOURNAL,

July, 1823.

ART. I. *An Account of the Eruption of Vesuvius, in October*, 1822. *By* G. POULETT SCROPE, Esq.

[With a Plate.]

Naples, March 10, 1823.

SINCE the end of the last century the great crater of Vesuvius has been gradually filled by the accumulation both of lava boiling up from below, and of scoriæ falling from the explosions of the different minor mouths which were formed at intervals during the last twenty years on its bottom and sides. When I visited the mountain in 1818-19, this great crater was almost entirely obliterated;—no regular concavity appeared, but in its place a rough and rocky plain, rising into two rude eminences at the northern and southern extremities, covered with blocks of lava and scoriæ, and cut up by numerous fissures, from many of which clouds of vapours were evolved in considerable quantities. By the eruption of last October this state of things has been totally changed. The explosions which then, during the space of more than twenty days, were incessantly and with terrific violence taking place from the focus of the volcano, broke up and threw out all this accumulated mass, and ended by completely *gutting* the mountain, so as to leave an immense gulf or chasm of an irregular and somewhat elliptical shape, about three miles in circumference if measured along the very sinuous and irregular line of its extreme margin, but somewhat less than three-quarters of a mile in its longest diameter; which is directed from N.E. to N.W. Its depth is perhaps rather above 700 feet, but decreases daily by the dilapidation of the sides.

The enormous quantity of matter which, previously to the eruption, occupied this space, was thrown out in fragments of every size, varying from blocks of some tons in weight, to the most impalpable powder. The greater part, however, certainly issued from the mountain in the latter form, having undergone a complete trituration during the process of continued and repeated ejection. After the first four days of the eruption, the substances thrown out were solely pulverulent, becoming finer, lighter, and of a lighter colour every day. These ashes as they are called, (certainly without much propriety, being only pulverized lava,) rose from the crater in dense and prodigious clouds, to a height, at one time, of nearly two miles, and were thence borne away on the winds to great distances, the heavier particles falling in showers from the line of clouds thus formed along its whole track. The vast crater, which was emptied by this violent process, presents an aspect very different from that which is usually assumed by the concavities of volcanic cones. These generally appear in the regular form of an inverted cone, whose sides slope at about the same angle to the horizon as those of the outer cone. This is, indeed, invariably the case with every cone which is produced by a single volcanic eruption. That of Vesuvius, however, resulting from the accumulated products of, perhaps, many hundred eruptions, must consist of numerous beds of scoriæ and fragmentary lava, alternating with the strata of lava rock, which at intervals have been poured in fiery torrents down its outer slope, and congealing there, have remained like so many massive ribs, to give strength and solidity to the structure. Through this succession of beds, then, has the present crater been forcibly hollowed out by the explosive energy of the volcano. It appears as a tremendous abyss of enormous proportions, surrounded by craggy precipices that rise almost vertically from the rude heaps of fallen fragments which form its floor, and conceal the volcanic orifice. The extreme periphery of the crater in some parts juts over these precipices, so that on attaining its margin you look directly down into the gaping cavity. In others, a steep inclined plane, of no great width, intervenes between the edge of the cliffs and the acute ridge in which the interior and exterior slopes terminate. On this inner and shelving surface it is necessary on many points to pass while making the tour of the crater; in general, it affords a firm and safe footing, being formed of the fine sand which was the last product of the late eruption, and into which the foot sinks to some depth; but, when the surface of this slope is hardened by frost into an unyielding and slippery crust, (which was the case on the morning of my first visit,) the passage is extremely perilous. The danger is, in fact, the same on the outer as the inner slope, since a slide or a false step would be probably fatal on either side; but the idea of falling into the crater is more appalling than that of rolling down the exterior of the cone.

The cliffs that encircle the great cavity by no means follow any regularity of curve, but project or recede in salient and retiring angles. Their abrupt faces which are rocky, jagged, and unpicturesque in the extreme, present sections of many currents of lava, some of which are of great thickness and extent, lying one above the other in a direction more or less approaching to the horizontal. Most of them offer a *columnar division* of the most marked and decisive kind. Some are almost as regularly prismatic as any ranges of the older basalts. In some the spheroidal concretionary structure on a large scale is equally conspicuous. Between the currents of lava are interposed shapeless beds of volcanic conglomerate, consisting of fragments of all sizes heaped together in chaotic confusion. These, as well as the beds of lava, are occasionally intersected by vertical or nearly vertical dikes, similar to those of Somma above the *Atrio di Cavallo*.

The whole scene presents, perhaps, an unparalleled example of the horribly sublime. The deep and yawning gulf, on the verge of which the spectator must hang to observe its terrors;

the rugged and fractured cliffs that frown around it; their gloomy colouring, and calcined aspect; the dense sulphureous vapours that rise from fissures on every side; together with the thundering echoes which almost at every minute proclaim the fall of some fragments detached from the sides into the abyss below; create a sense of grandeur and awe, too impressive to be easily effaced. The great crater of Ætna, even if larger, which I much doubt, is in my opinion by no means so striking. Time and the meteoric agents have considerably softened the features of this last scene, while there is a vivid and terrible freshness in the crater of Vesuvius; the wound which has been torn through the bowels of the mountain is as yet raw and unhealed; and the imagination forcibly recurs to that powerful demonstration of the energies of Nature in all their violence, which so lately was exhibited from this spot, and which is liable to re-commence at the instant.

Viewed from a distance, the crater still appears to emit at all times a considerable quantity of smoke, which increases prodigiously during stormy weather. However, on attaining the summit of the cone, it becomes evident that little or no vapour rises from the concealed vent of the volcanic focus at the bottom of the basin. Thick clouds, on the contrary, take their rise just within the margin of the crater, evolving themselves from fissures in the broken extremities of those currents of lava which were produced by the last eruption, and which without doubt are still at an extremely high temperature, probably, indeed, incandescent and liquid at their centre, since paper and wood take fire immediately on being thrust to a certain depth in their clefts. The slowness with which lava conducts caloric is well known. It is, therefore, to be expected, that the fall of rain in any quantity would proportionately increase the activity of these vapours, which are almost solely aqueous. The moisture deposited on the surface of the recent lava currents, that nearly envelop the whole cone, percolating to the interior, becomes converted into steam, and forces its way through the longitudinal rents or channels that occur in every lava current, and particularly in those whose course has been rapid, until it issues at last in clouds from the ragged edges of the stratum at the margin of the great opening.

The great cone of Vesuvius has lost considerably in height. A very large excrescence on the south side, resulting from the accumulated ejections of three or four minor mouths, and forming its most elevated point, fell in during one of the most violent convulsions of the last eruption; so that the opposite or north side of the crater is now the highest peak of the cone. By barometrical measurement I find it to be 3829 feet above the sea. The lowest part of the ridge, forming the periphery of the crater, is on the east side above Pompeia, and 3346 feet in height. The absolute elevation of the mountain has been diminished by rather more than 100 feet, while the bulk of the cone has been greatly increased by the lava torrents that clothe its sides, as well as the still greater mass of ejected fragments.

Amongst the latter products are some few pieces of granite, and of crystalline limestone with mica, Vesuvian, *&c.*, precisely similar to the erratic blocks which so frequently occur in the conglomerates of the Monte Somma; and hence it appears that the explosions of this recent eruption have shattered and blown into the air a portion of the strata belonging to that older volcano. But by far the greater number of ejected blocks, with which the slopes of the cone of Vesuvius have been strewed by the late eruption, consist of leucitic lava, and are evidently fragments forcibly torn off from those currents of an earlier date, whose sections are seen in the broken and precipitous cliffs of the crater. Many of these lavas have a highly torrefied aspect. They have obviously undergone a *recoction*, if the expression is allowable, either from having been exposed for ages to the heat, which, in the centre of the cone, from whence they were probably torn, must have been always intense, or during the period of rejection by the present eruption, having perhaps more than once been vomited forth and thrown back again into the burning gulf, before their final landing on the exterior of the cone. These fragments exhibit a more or less pearly lustre, apparently in proportion to the greater or less degree of torrefaction they have endured. The fusion of the leucites seems to be the cause of this appearance. In some specimens this process has been carried to such extremity that a portion of the lava has run into a black glass, which fairly merits the name of *Leucitic Obsidian.* In colour, fracture, and transparency, this substance resembles the common trachytic obsidian of Lipari, but differs from it in melting before the blowpipe into a black glass, while the obsidian of Lipari is well known to produce one of a greyish-white colour.

But this is not the only alteration produced on these erratic blocks of lava, by their re-exposure to the intense action of the volcanic furnace. In some cellular specimens, the cavities are thickly lined with crystals of specular iron, and of various other minerals, hitherto undescribed, if not unknown. Amongst these, the most remarkable are delicate capillary crystals, which are found by the lens to be hexagonal prisms, hollow within, formed by the lateral junction of six long rectangular plates. They are either white, or of a light flesh-red colour, and occupy cavities which seem to have been produced by the total or partial disappearance of the larger crystals of *leucite.* Acicular radiated mesotype occurs in the same manner; as well as brilliant crystals in rhomboidal dodecahedrons, of a dark-green colour. These new crystalline minerals, thus, to all appearance, created out of the elements of a lava composed simply of leucite and augite, during its re-exposure, under peculiar circumstances, to the action of volcanic heat, may be expected to throw a useful light on the origin of the numerous and problematic minerals occurring in those erratic blocks of crystalline limestone, *&c. &c.*, of the Monte Somma, which appear to have undergone a similar process during the activity of that ancient and enormous volcano; and a stronger degree of probability is thus added to the opinion, by which these blocks of limestone, with their accompanying mica, augite, garnet, vesuvian, nepheline, *&c. &c.*, are supposed to be, not unaltered fragments of primitive rocks, but portions, perhaps, of the calcareous or other strata which once covered the site of Vesuvius, variously affected by repeated and continued exposure to the influence of the mysterious and ever-varying phenomena which take place in the fiery depths of the volcanic laboratory.

In a chemical light, the eruption of last October distinguished itself from all preceding ones by the excessive abundance of sulphur deposited by the vapours evolved from the lava it produced. The various chemical products of these fumarole have been collected and analyzed, with great care, by Messrs. Monticelli and Covelli, who have been closely occupied, since the date of the eruption, in preparing for the press a descriptive work on the subject, which will probably be out in a few weeks, and, I have no doubt, will prove extremely interesting. If I can discover any method of forwarding it to England, I will despatch it as soon as published. In the mean time, perhaps, these brief remarks may help to gratify the curiosity of the readers of this Journal.

Perhaps, it is worth while to mention, that the appearance of the actual crater of Vesuvius offers a complete confirmation of the opinion I was led to adopt in France, as to the identity of the circus or upper basin of the Dordogne, in the Mont D'or, with the principal crater of that extinct volcano.

Were the fires of Vesuvius to be in turn extinguished, and its activity cease from this moment, (a circumstance by no means *impossible*,) a few centuries would probably see the interior of the crater laid open by a valley, through which the waters accumulating at its bottom, would discharge themselves into the sea; and in this event, the resemblance to the upper circus of the valley of the Dordogne, would be most strikingly exact. The lofty and precipitous rocks encircling each basin offer the same general characters; equally ragged, shattered, and calcined, they are composed alike of conglomerate beds, alternating with strata of lava, prismatic or not, and intersected occasionally by vertical dikes. From the margin of these cliffs, in either case, the outer flanks of the cone shelve downwards, with a steep and regular slope, to the base of the mountain.

Another interesting parallel may also be drawn between the large accumulations of volcanic sand (or ashes) and fragmentary lava, (commonly called lapillo,) washed down from the sides of Vesuvius by the rains, which fell with great violence during the late eruption, and those large deposits of tufaceous conglomerates, in the volcanic country of France, to which I assigned, upon the spot, a similar origin. Nothing could be more confirmatory of the justness of that hypothesis, or more clearly illustrate the mode of formation of such rocks, than the phenomena which took place on all sides of Vesuvius, a few days after the great crisis of the eruption in October last. The fine impalpable sand thrown out from the crater for many days together, had covered the surface of the mountain to the depth of from one to five feet; and necessarily impeded whatever rain fell upon this space, from draining off, as usual, through the porous and loose matters which compose the sides of the volcano. In this state of things, on the 27th October, the clouds, which had long gathered in dense masses round and above the cone, began to discharge their contents in prodigious quantities; and, in consequence, torrents of sand, mixed with water, appearing like liquid mud, swept, with terrible impetuosity, down the slopes, tearing them up in their passage, hurrying along fragments and blocks of lava, of great size, (some even from 40 to 50 feet in girth,) and depositing heaps of alluvium on the sides and at the foot of the mountain. The damage occasioned by these "*lave d'acqua,*" or "*di fango,*" as they are called in the language of the country, was far greater than what was suffered from the "*lave di fuoco.*" The latter only destroyed a few acres of wood and vineyard, but by the former a much larger space of cultivated soil was devastated, walls were overthrown, houses and streets filled with sand and stones, and some lives even lost, from the suddenness of their descent.

There can be no doubt, that a great portion of the tufa strata, under which Pompeia and Herculaneum lie buried, were deposited by alluvial torrents of this nature; and I make no question, but that parallel phenomena, on a larger scale, produced those massive formations of tufas and breccias, which shew themselves in such abundance around and upon the extinct colossal volcanoes of central France.

P.S.—I open my letter to say, that accounts have just arrived from Sicily, of an earthquake having done great damage in that island. Palermo has been shaken dreadfully, about thirty lives lost, and houses injured to an extent of loss equal to half a million sterling, it is said. Messina and Catania have suffered much less. It is difficult to say whether this calamity has any connexion with the eruption of Vesuvius last year, or with the dreadfully stormy weather we have had since. It is a very unusual phenomenon at Palermo.

References to Plate.

(A) Lowest lip of the crater immediately above Bosco Ire Case, and facing Pompeia. In this direction the side of the cone was split open during the eruption, and a large crevice formed, which threw up lava, scoriæ, and sand, on five or six points.

(B) Punta del Palo, the highest peak of the actual cone, and fronting the North.

ART. II.—*On Mineral Veins.* By J. MAC CULLOCH, M.D., F.R.S. Communicated by the Author.

IN a practical view, there is not a subject in the whole range of geology of greater importance, than that which relates to the history of mineral veins; and, accordingly, there are few that have been more examined. Neither is it by practical miners alone that this subject has been investigated; since theoretical geologists have not only compared, and reasoned on, the facts which these persons have brought to light, but have themselves, on many occasions, undertaken the labour of personal examination. It is, nevertheless, true, that, excepting in a very few particular cases, confined to narrow districts, which have been the subjects of great experience, no general rules have been established, from which any useful practical results have been deduced, or which are capable of laying the foundation of a rational theory respecting their formation and origin. We can neither conjecture, *à priori*, in what districts or in what rocks they are to be expected, what courses they hold, what various forms and accidents they may display, nor what substances they contain. Where little information can be procured, much will not be expected.

Although mineral veins may exist without necessarily containing metallic substances; yet, as the general characters of these are the same, they do not require to be distinguished here, farther than as may relate to the nature of their contents. Minerals of many kinds are also occasionally found in repositories which cannot properly be called veins, and metallic substances are not even limited to these. To describe these latter cases first, will be to clear the present inquiry of circumstances which would otherwise encumber it.

Many metallic minerals are found scattered among the constituents of the compound rocks, so as almost to form parts of their composition. Thus, oxydulous iron is found in granite, gneiss, sandstone, and trap; molybdena in gneiss; and iron pyrites in slate, shale, and limestone. They sometimes, also, occur independently; neither forming part of the composition of rocks, nor included in distinct repositories. In this way, pyrites is found in innumerable situations; copper in the trap rocks; and oxydulous iron in the products of volcanic fire. Lastly, some of these are found accumulated in such quantities in particular spots, still without forming veins, as to admit of being wrought for economical purposes. Cobalt thus occurs in sandstone, as does copper. Iron, in the form of ironstone and bog-ore, is known to abound in beds; the first among the coal strata, and the latter in alluvial soils. Thus, also, tin and gold are found among alluvial soils; but, in these cases, the origin of the metals is, without difficulty, inferred to be in distant veins. It is likewise understood, that manganese occurs in the form of beds; as has also been said to happen with respect to mercury, copper, lead, and silver; but it is necessary to remember, that veins, holding a course parallel to the including strata, have sometimes been mistaken for beds.

Such parallel veins are, however, sometimes distinguished by the term of *flat*, while the intersecting ones are called *rake* veins: but, as no useful information is communicated by the adoption of provincial and technical terms, they are here avoided. Geology can gain nothing by being further encumbered with terms that only produce an unnecessary jargon; and it is the duty of every one to avoid sullying the English tongue. To shroud in the mystic terms of any science or art, whether in the phraseology of miners or the symbols of algebra, that which can be expressed in ordinary language, is either the result of a worthless ambition, or a proof of the superiority of the memory to the understanding.

Of the Forms, Positions, and Relations of Mineral Veins.

Mineral veins, like rock veins, intersect the strata at all angles, and are also occasionally parallel to them, throughout more or less of their courses. They imply a discontinuity of the rocks through which they pass, and are, in fact, composed of matter which has entered into the fissures that have been formed by the causes which influence the positions of strata. Hence, it is easy to understand how they are accompanied by those dislocations of the including strata, the varieties of which are numerous; although a fissure does not necessarily imply a dislocation.

As veins may hold any direction with regard to the including strata, so they may be placed in any position towards the horizon. But from a mere comparison of chances, it is plain that they must be far more frequently inclined than vertical; whence miners learn to distinguish between the upper and under sides of a vein. It is observed, that when mineral veins occur in considerable numbers in any tract of country, they maintain a sort of general parallelism; as if all the fissures to which they owe their origin had been formed, at the same time, by some common cause, or had been produced by the successive repetition of similar actions. This, also, it is remarkable, is sometimes the case where more than one set of veins exists, and where the posteriority of the one is proved by their invariably intersecting the other. This fact is remarkable in Cornwall, where the more ancient veins are directed, in a general sense, from east to west, and the more recent from north to south.

Their longitudinal extent must evidently be limited, but it is often considerable. They have been traced for two, and even three, miles, in Cornwall; and it is said that one vein, in South America, has been ascertained to extend for 80 miles.

It is easy to see, however, that in a case of this nature, the union of some tendency to system, with a little inaccuracy, may easily confound many veins together. Observations made in such a spirit of extravagant generalization, must necessarily excite distrust, when we advert to the comparative length and breadth of such a supposed continuous fissure, and to all the circumstances under which these must have been formed.

The breadth of veins is extremely uncertain, varying from less than an inch to many yards. The question of their depth is more interesting, as it is believed by some to be indefinite: it is at least said, that their depths have never been reached by miners. If that were even true, it would not prove the truth of an opinion so improbable, when we consider the circumstances under which fissures must have been formed. When the separated or dislocated strata preserve an accurate parallelism, the same relative disposition must exist between the opposite sides of the vein; and we may thus, if we please, imagine it interminable. But if the including strata have lost their parallelism after separation, it is evident that, under one modification of this, they may, or rather must, come into contact in some part of the series, and that the vein will therefore disappear. This reasoning only takes a simple view of the consequences resulting from the appearances; but if the hypothesis of some geologists should be admitted, which supposes that the materials of veins were ejected from the depths of the earth, then indeed they may be indefinite in their downward progress. But this is pure speculation.

The absolute antiquity of veins, in any situation, is a subject respecting which no conjectures can be formed; but there are two modes of judging of their ages, within certain limits. It is evident, in the first place, that they are all posterior to the in-duration of the strata, as they always imply fracture of these. If, again, it shall be proved that any veins are found in the primary strata, which do not also exist in the secondary, it will follow that they are of a more early origin than the deposition of the latter. It may be imagined, for example, that the veins of Cornwall are of a prior date to the formation of the English secondary rocks, because they do not occur in the secondary districts. Yet there is no proof of this; unless it could be shewn that secondary strata existed unbroken above these veins, or until tin or copper veins shall be found in the primary rocks, after removing the secondary, in the districts in which these exist.

That there are veins of different ages, is, however, rendered certain where two exist, and where, as often happens, the one intersects the other. This circumstance is not uncommon on an extensive scale. In Cornwall, a large proportion, probably all, of the easterly veins, are intersected by the northerly; and it is remarked, that the former are metalliferous, and the latter wanting in metals.

These intersections are attended by circumstances as interesting to geology, as they are important in the art of mining; in which they are often the source of much labour and expense, and even of ruin. As the first class of veins are frequently attended by dislocations of the strata, the same accidents attend the second; and, in the latest motions of the including rocks, it evidently follows that the first order of veins is included. Thus, in technical language, the effect of a second vein is to produce a shift in the first, often attended by circumstances, in the state and nature of its contents, which will be examined hereafter.

The extent of such dislocations in veins is variable; as may easily be understood from the remarks formerly made on the motions of the disrupted strata, in which they, necessarily, partake. Their direction is an object of the highest interest to the miner; as it is only by being able to form some previous judgment respecting it, that he is taught where to seek for the interrupted continuation of that which he has lost. Experience, in different countries, often forms a tolerable, though not an infallible, guide for these; as must be very evident from considering the irregular displacements of strata: but such rules are still less capable of being extended to other countries, or to remote places. To determine whether the motion of one part of an inclined vein is to be termed an elevation or a depression, it is necessary to take the point of departure from the surface, as in the case of dislocated strata. When a vertical vein is shifted, it is evident that the adjacent rocks must all have been moved by the same quantity in a horizontal direction; an event, as formerly remarked, not favourable to the theory which supposes the fractures of strata to be the effect of subsidence.

The last circumstance which relates to the forms of veins, is their ramification. They are occasionally separated, and again reunited; certain technical terms being, in mining countries, applied to the intermediate mass. In other cases, they send out slender ramifications; and sometimes they are found to ramify, at once, into many small branches.

I have thought fit to separate from that which is matter of justifiable inference respecting the ages of veins, what can only be considered as an hypothesis, and which is, further, neither an intelligible nor an useful one. It has been said, that there are epochas to be traced in metallic veins, or that the metals are of different ages. Thus, for example, it is said that tin is among the oldest metals, because it is found in granite, and that lead is among the newest, because it occurs in the secondary limestone. I need not enumerate all the particulars contained in assertions so unfounded; while a few simple facts are sufficient to annihilate the whole system.

Cobalt occurs in granite, in many of the primary schists, and in the secondary sandstones. Copper has been found throughout the whole system, from granite up to trap inclusive. Lead is found alike in the primary and secondary strata, and iron is universal. I need not extend a list of exceptions that overwhelm the rule. If, again, the nature, or imagined age, of the rock which is traversed by a vein, is to be made the criterion of the age of the latter, or of the included minerals, it must be remembered, that a vein must traverse every rock that was in existence at the time of its formation. The vein that intersects the granite, intersects the superincumbent strata also; and tin, copper, or lead, as it may happen, will occur in every part of it. It may have required uncounted centuries to form all the strata, but the vein is, comparatively, the work of a moment. It is a separate question, to what extent the adjacent including strata modify the contents of their veins; and it is one that will be examined hereafter.

Lastly, to attempt to classify metallic veins according to the nature of their contents, is to make arrangements worthy only of the cabinet mineralogist; systems which philosophy disclaims. If there were an hundred, for example, instead of ten or sixteen *lead-glance formations,* we must be content to remain ignorant of the ages of all that we cannot prove by the incontrovertible marks already indicated.

There is not one circumstance, in the history of veins, whether we regard their forms, positions, seats, origins, or the nature and disposition of the minerals which they contain, which can entitle us to conclude that they possess a resemblance or analogy throughout the world; that they are of definite and definable ages; or that they are, in any sense of the word, general or universal. Yet this doctrine is supported by geologists, who imagine that the mines of New Spain are similar to those of Hungary and Saxony. That Patrin, who had imagined the earth organized and endowed with a vital principle, should protract a zone of copper, silver, and lead, from England through Europe, Asia, and America, may be excused. But it is an abuse of the term generalization, to extend it alike to the visions of theorists and the inductions of philosophers.

Of the Seats and of the Contents of Mineral Veins.

The nature of the rocks in which mineral veins are found, is in every respect an interesting object of inquiry; but it is necessarily very limited, and, what is worse, cannot be converted to any useful purposes. They may be said rather to belong to countries than to rocks; since, in one, that substance may be highly productive of veins and metals, which, in another, is deficient and barren. That they are most abundant in the primary or ancient rocks, is, however, certain. They are also more common in the stratified substances, namely, in gneiss, micaceous schist, and argillaceous schist, than in granite, or in the older porphyries. In the secondary or recent strata, they occur chiefly in the lowest, as in that which has been called in England the mountain limestone, and are scarcely found in the upper strata, or above coal. In the same manner, they are rare in the later trap rocks: but, if Hacquet's observations are correct, they occur at Nagyag, either in these, or, as he thinks, in ancient volcanic rocks.

In the primary rocks, they are sometimes found at the junctions of granite with the strata, as happens in Cornwall and at Strontian. But it is fruitless to attempt to derive any practical advantages from any thing yet known on this subject; unless as the experience acquired in particular districts may be a guide for these. The limitation of tin to Cornwall and a few other spots, and its exclusion from countries formed of the same materials,—the barrenness of gneiss in Scotland, compared with its fertility in Saxony, may be added to a thousand other instances, to prove that we must be content to possess mines wherever they are found, without wasting our hopes and our means in vain endeavours after them, where we have no evidence of their existence. That much false philosophy should have been adopted on the subject of mines, is a natural consequence of that perversion of judgment which so often attends the pursuit of wealth, and of that subversion of the reasoning powers which is produced by examples of its sudden acquisition.

The contents of mineral veins are various; and although the metallic substances form the most valuable part of them, they bear a very small proportion to the rest. No general rules respecting these contents can be given, as they vary in almost every country, in every vein, and, often, in every part of a vein. It is common, however, to find that the sides next to the including rocks are formed of earthy matters of very ordinary aspect. In some cases, this substance is clay; in others, quartz is found; and, not unfrequently, it consists of a conglomerate formed out of fragments of the bounding rocks, united by various crystalline and earthy substances. It is common, in these cases, to find that the including rock is more or less decomposed and altered, at its junction with the vein. It has also been observed, that large detached fragments of the neighbouring rock are sometimes included within the body of the vein. In some cases, this occurrence presents an interesting variation; as, when a vein traversing schist and granite together, is found to contain fragments of the former within the space bounded by the latter, and the reverse. This fact serves to prove the extent of the revolutions, of a mechanical nature, which must have taken place in the vein; either at the time, or after the period, of its formation.

It is unnecessary to enumerate all the earthy minerals which have been found in veins; but the most common are quartz calcareous spar, barytes, and fluor. These, like the metallic substances, are found in different parts of the vein, and are crystallized in different forms, wherever cavities are present. The metallic minerals are found variously disposed; sometimes lining similar cavities in their crystalline forms; at others, collected into lumps, or deposits, in different parts of the vein; and at others, again, more generally diffused among the general mass of materials. In some instances, only one metal is found in a vein, in others, two or more; and these are sometimes distinctly separated, at others intimately mixed, so as to be a source of much trouble to the miner. It is occasionally found that the minerals, whether metallic or earthy, are arranged in layers parallel to the sides of the vein; and, in some of these instances, there is, further, a perfect correspondence on the opposite sides. Such, also, is the capricious disposition of the metals, that they sometimes disappear altogether, after having abounded through a large space; so that it becomes necessary to abandon a mine that had once proved very profitable. It is owing to these perpetual variations in the contents of mineral veins, that the characters of particular mines are subject to such important alterations, and that chance, in the ordinary acceptation of the term, baffles all the calculations of the proprietor. Yet rules are still to be found in every mining country. These, too, are, unquestionably, of occasional value in practice; but they are always local, and if they may sometimes serve valuable purposes in practice, they offer no facts on which a philosophical geologist can possibly reason.

The intersections of veins are sometimes observed to produce variations in the nature and disposition of their metallic contents; but these, like most other rules, are of a local nature. It is also said that masses of ore are found at the intersections of more recent veins, and that intersecting veins of different periods, necessarily differ in the nature of the metals which they afford. It is asserted, further, that in Cornwall, "if two metalliferous veins cross from opposite sides of the line perpendicular to their intersection, they become less productive at and after the junction; but that, if they cross from the same side of it, the reverse effect takes place." It is further there remarked, that, "after the intersection of a more recent vein, the metallic produce of the ancient vein disappears." If any remarks of this nature have a value, it is not very intelligible. The same proposition is both true and false at the same time; since it is evident, that where the miner may have chanced to work in an opposite direction, the very reverse effect must take place. Like too many other conclusions of a similar nature, their chief value consists in warning us not to rely on observations made at hazard, and guided by no principles.

There is one circumstance, however, respecting the variation of the contents of metalliferous veins, which is of importance towards a rational theory of them; if, indeed, it should prove to be really founded on facts sufficiently extensive.

It is said to be a general remark, that, in all countries where veins traverse strata of different natures, their metallic contents vary with some relation to these; and that, in the same vein, the vicinity of some strata renders the vein more productive than that of others. But the facts adduced to prove the truth of this observation are neither very numerous nor very definite;

it remains to be seen, by a further extension of rational and unbiassed investigations, whether they are not swallowed up by a mass of exceptions. It is said, for example, that in a vein near Callington in Cornwall, passing through schist and granite, the copper which it contains is found in the former, and the tin in the latter, part. It is further said, that in Cornwall, similar veins are poor in the schist, and rich in the granite. It is also asserted, that veins are most productive at the junction of the schist and granite, not only in Cornwall, but in Silesia and elsewhere. There is not one example of this nature, to which there are not exceptions many times exceeding them, for which the reports of the same observers may be consulted. It would be endless to quote instances; as it would be fruitless here to record all the observations that have been made on these subjects; since the conclusion would be, to draw, as might equally be done without them, no conclusions. Whether, on the subject of the influence which strata have over the contents of veins, any exception ought to be made in favour of Derbyshire, where this is said to occur, it seems fruitless to ask; until miners shall fairly enter on the field of accurate observation, or geologists, discarding their prejudices, shall seriously turn their attention to a branch of the science which is, most particularly, its opprobrium.

Of the Theory of Mineral Veins.

On such a foundation, it has been attempted to build theories of mineral veins; and, as is usual in similar cases, the opposing opinions have been maintained with a vehemence proportioned to the want of evidence on both sides. It is necessary to state these two hypotheses, before inquiring into the circumstances by which either of them may be countenanced or opposed; and it is scarcely necessary to say, that the only important question at issue, concerns the manner in which the contents of the veins were formed and introduced; as the fissures in which these are contained have formerly come under review.

It is said, on one hand, that all the materials of veins have been deposited from the same universal solution whence the rocks were, on the same hypothesis, formed. But there are two modifications, at least of this aqueous theory. While the rocks were in the act of being precipitated from the universal solvent, the veins were undergoing the same process; and hence they are esteemed to be of different ages, corresponding to those of the strata or rocks in which they lie. How such an operation could be effected is not explained; and it is fruitless to inquire, where, in lieu of ideas, we have only unmeaning words. Time may be better employed than in labouring to account for what is impossible. In the other modification, the fissures were formed in the rocks yet soft or yielding, by drying and contraction; and the metallic or other minerals, remaining in the solution after the precipitation of the rocky materials, were then precipitated in these fissures.

On the other hand, it is maintained, that the same power of subterranean expansion which produced the fracture and dislocation of the strata, introduced the materials into the veins, and that they have crystallized from a state of fusion, not of solution in water. Neither of these theories will require a very long examination; but the arguments that relate to both are, in some cases, involved together.

With respect to the aqueous hypothesis, it involves the same fundamental objection made to the precipitation of rocks from solution in water: it is at variance with the laws of chemistry. That objection would still be a fatal one, though the hypothesis should be limited to the filling of veins alone, though it were conceded that the rocks had been produced in some other manner, and though the production of veins was admitted to be posterior to the consolidation of the strata in which they lie. Even if the power of this imaginary universal solvent were granted, the difficulties are still insuperable; unless it could be proved why the metallic or other minerals of veins were not deposited every where alike; why, like those which form rocks, they were not deposited in strata; and why they were not only directed exclusively to fissures, and to a few of these in distant and select places, but limited even to partial spots in the same vein.

These are the leading objections to the general hypothesis, and they are unanswerable. The few real arguments from facts which have been adduced in support of it, are of small value, and will require very little discussion.

If it be conceded, as is the fact, that many of the substances found in veins are the produce of watery solution, there are many others which, as far as we yet know, cannot be produced in this manner. Not to enumerate all these, it is sufficient to notice in general, the greater number of the metallic minerals. It has been argued, that the minerals of veins are deposited in layers parallel to their sides, precisely as ought to have happened on this hypothesis. To this it is easily answered, that the fact is not so, except occasionally; as they are frequently congregated in irregular lumps, or dispersed among the other materials, or wanting for considerable spaces, or found lining the insides of cavities. Neither of these occurrences ought to be found, according to the hypothesis; and, more particularly, there could be no cavities on such a system of deposition from above. In such a case, also, the layers of minerals ought rather to be parallel to the horizon than to the walls of the vein. The argument derived from the presence of rounded materials in veins is worthless, because the fact itself is extremely rare. It is an exception instead of a rule, and may be admitted without involving the whole hypothesis.

With respect now to the other theory, which presumes that the contents of mineral veins have been injected from below, as those of granite and trap veins have been, the difficulties are assuredly not less, if they are not even greater. The arguments for it rest partly on this very analogy; partly on real or imaginary chemical facts relating to the production of minerals by fusion; partly on some mechanical appearances; and partly on the principle of dilemma. If it be really a case of dilemma, the one horn appears as fatal as the other, and there can be no theory of mineral veins.

The argument from the analogy of trap and granite veins is exactly one of those superficial resemblances, consisting in words rather than things, which it is painful to find in the writings of such philosophers as those by whom it has been offered. It serves to shew how weak the best of us are, when we suffer our prejudices or our wishes to interfere with our powers of reasoning. It may be conceded, that the fissures have been produced by the same subterranean changes which have displaced the strata; yet this admission does not involve a concession to the rest of the hypothesis. It does not necessarily follow, that the mineral contents of these veins have been injected from beneath in a state of fusion, although the power of heat may have been the cause of the fissures themselves. The presence of fragments of the including rocks in the veins, which has also been used as an argument for this theory, is a fact of just the same value; it proves the forcible displacement and fracture of the strata, but nothing more.

As to the chemical arguments derived from the insolubility of many of the contents of mineral veins in water, and their production from fusion, it is easy to shew that many of them certainly are produced from solution; that many others may have been generated in this way without a breach of chemical laws; and that some of them could not have been consolidated from fusion. I shall reserve these particulars for a general view at the end of this paper, when the several minerals producible in either mode will be enumerated.

In the mean time, it is impossible to conceive how, if the contents of these veins had been injected in a state of fusion, the fragments so often found in them should have escaped this process. I will not here say, as has also been objected, that clay could not have been found in mineral veins on this principle; because it is easy to understand how the infiltration of water should have decomposed portions of the veins, in the same manner as rocks are converted into clay, though deeply situated beneath the surface.

Whatever objections may be made against the aqueous hypothesis, from the peculiar dispositions of the minerals in the veins, are at least equally valid against the igneous one. It is impossible to comprehend how these could have been produced from a state of igneous fluidity, any more than from a state of solution. It has also been said by the supporters of this hypothesis, that the absence of the solvent water from the veins is a proof that their contents were not deposited from water. It assuredly does not prove that; while, as it respects the igneous theory, it is merely an argument from dilemma, that proves nothing in its favour, if it be not truly a case of dilemma. In having recourse to this species of reasoning, the first step is to establish the necessity of the alternative.

Another imaginary chemical argument has been derived from the mutual impressions of co-existent crystals in the veins. This is a view founded on the nature of granite, and other rocks crystallized from fusion; but it is an analogy which has been abused, no less in this case, than in that which relates to the nodules of the amygdaloids. The mutual impression of quartz, or of chalcedony, and calcareous spar, does occur in these, from successive infiltration and crystallization; and, according to the order in which these substances are deposited, either may impress the other, as I have fully shewn in my work on the Western Isles. It is perfectly consistent with this to imagine, that any number of minerals admitted, at distinct intervals, into cavities, should present the same appearances; and that, in modes much more complicated than could happen from any simultaneous crystallization from an uniform fluid of fusion. But, in truth, though the inconceivable chemical agencies required to separate all the minerals that are found in a compound rock, have been made almost a subject of ridicule against the supporters of aqueous theories of rocks, it would be difficult to imagine any process more difficult than that which should crystallize all the variety of earthy and metallic minerals that are sometimes found together in veins, from an uniform fluid of fusion. Chemists who will bestow a moment's consideration on this subject, will see without difficulty what it is unnecessary to detail here.

Some farther arguments, as much mechanical as chemical, have also been adduced in favour of the igneous hypothesis. It has been said, as an argument from dilemma, that, on the aqueous theory, no close veins or deposits of minerals, surrounded on all sides by rock, could exist. But it is obvious that these are equally impossible, on the other view of a cause. Where there is no access for a watery solution, there is none for an igneous fluid. To make use here, as has been done, of a theory of igneous secretion, such as been applied to the nodules of trap, is to adopt a scheme which is perfectly gratuitous, and to reject one the existence of which is proved. If mineral veins have, in any case, been filled by a secretion from the including rocks, there can be no choice between a process which is actually proved to exist in nature, and one which, not only has not been observed, but which is supported by no chemical analogy.

It has also been said, that the solidity or fulness of mineral veins could only have happened from igneous injection; as the abstraction of the water after deposition, must have left cavities or vacuities of some kind. With no small want of reflection, it has also been said that cavities could only have been formed in them on the igneous hypothesis, from the disengagement of elastic fluids. These, it is plain, are conflicting statements; as, without a charge of captiousness, may be fairly urged. The fact, such as it is, is quite as explicable on the one hypothesis as on the other, and is alike worthless to both. The want of marks of gradual and regular deposition, is a negative argument, which, if it proves one hypothesis to be wrong, does not render the other right; and, with respect to the existence of fragments already mentioned, the state of these is assuredly calculated to prove any thing but that they have been supported and involved by an ignited fluid.

Such are the objections to an hypothesis, which, however it might be deemed a necessary part of the general theory to which it belongs; and, however we may respect the talents of its author and supporter, cannot command a moment's attention, unless it shall hereafter be most materially modified by new views and new discoveries. Thus modified, it must indeed disappear; but its downfal does not involve that of the theory which considers granite and trap of igneous origin, and which maintains that the strata have been elevated by forces directed from below.

The pleasures of doubting have no charms to induce me to give this discussion so conspicuous a place as it here occupies. But facts are required by the reader; and, it is the duty of the author to see that they are not so managed by theorists as to mislead him; to place them so in array that he may form the conclusions which they seem to justify; even though these should leave the subject as they found it. The strength of assertion which has been brought into this question on opposite sides, leaves no choice in this case; and, if the discussion shall be said to prove nothing, it must be recollected that, to prove the existence of falsehood, is, in these cases, the first step towards truth.

Of the Minerals which are respectively produced from Solution, and from the Action of Fire.

It remains now, as was promised, to examine by our chemical and mineralogical experience, how far any of the substances found in mineral veins are the produce of crystallization from watery solutions, and in what cases they are crystallized from a state of igneous fluidity, or from sublimation. It is not intended to enter at large into this subject, because our information is still incomplete. A general view alone will be sufficient for the present purpose. The facts themselves, as they regard the two theories which have been examined, are singularly conflicting; although as far as they offer arguments for either, the balance is palpably in favour of an aqueous one. It is evident that these are the facts on which any future hypothesis must chiefly rest; whatever further considerations may be required for explaining the various circumstances of other natures which attend mineral veins.

In inquiring first respecting the earthy minerals, and in trying to determine the number of those which may be produced from watery solution, we are compelled to have recourse almost entirely to the chemistry of nature; as the limited solubility of the earths prevents us from deriving much information from our own circumscribed and cramped experiments. For the sake of brevity, I have thought it expedient to throw them into the form of a list; and, to save repetitions of the proofs on which their aqueous origin rests, these may be here given in a preliminary form.

The formation of quartz, chalcedony, and calcareous spar, may almost be witnessed; and that of the latter in particular is so rapid, that it can be seen in calcareous caverns nearly as well as the crystallization of ordinary salts. This substance is generated both by infiltration, and in solutions of carbonat of lime. Chalcedony is produced in the former way, and quartz in both. In the work to which I have already referred, it was also shewn that those veins which consist of quartz or carbonat of lime, are generated in this manner.

In the remarks on the amygdaloidal structure, to be found in the same place, I have proved that the theory of infiltration explains the imbedded nodules of the rocks of this character, and that these have been produced in this manner. Thus there is established a considerable list of minerals formed by means of aqueous solution. That which takes place in this case may equally happen in a mineral vein.

Although we have not yet proved that all the other earthy saline minerals, as they are sometimes called, such as gypsum, barytes, *&c.*, are produced from watery solution, chemistry and analogy both render it very probable; and these may therefore be added to the aqueous list with little hazard of error; certainly with much less than they could be referred to an igneous origin. Lastly, we may pretty safely also refer to the same division, those which are found associated or imbedded in quartz, as disthene is.

The list, constructed from these various kinds of evidence, will therefore contain the following minerals, and possibly many more; and, it is here divided under these several heads of more or less unexceptionable proof. I do not add those which are imbedded in primary limestone, because it is possible, or more than possible, that some of these have undergone the process of fusion; in which case their imbedded minerals must be referred, as those of granite are, to an igneous origin.

SALINE MINERALS.

Carbonat of lime.
Fluat of lime.
Gypsum.
Brownspar.
Arragonite.
Wavellite.

Carbonat of barytes.
Sulphat of barytes.
Carbonat of strontian.
Sulphat of strontian.
Boracite.

With respect to some of these, it will be perceived that the proofs are complete, as they are found in the following division:

MINERALS OF THE AMYGDALOIDS.

Quartz; including amethyst.
Chalcedony, in all its varieties.
Opal.
Sulphat of barytes.
Fluor spar.
Olivin.
Epidote.
Mica.
Chlorite.
Steatite.
Lithomarge.
Chlorophæite.
Conilite.
Brown spar.

Mesotype.
Nadelstein.
Leucite.
Sulphat of strontian.

Prehnite.
Laumonite.
Ichthy ophthalmite.
Harmotome.
Analcime.
Stilbite.
Chabasite.
Arragonite.

To which may be added, as found sometimes in aqueous quartz,

Disthene.
Epidote.

Tremolite.
Tourmalin.
Actinolite.

And as found in calcareous spar,

Emerald.

I have here limited the list of aqueous minerals strictly to those which are supported by the proofs above-mentioned; but, if those also had been enumerated which are found associated together in cavities of veins, where one or more of the number consists of minerals decidedly aqueous, it might have been considerably extended. The mineralogical reader who is thus furnished with the principles on which this catalogue has been constructed, may easily pursue further what it is here unnecessary to detail more minutely.

In examining now the metallic minerals, so as to determine which of them may have been formed from aqueous solutions, we may first have recourse, partly to direct experiments in our laboratories, and partly to analogies drawn from these. The ready means which chemistry affords for producing many of these substances, render these artificial proofs, if they may be so called, much more complete than in the case of the earthy minerals.

The other kind of proof which may be considered natural is, as in the former case, drawn from their association with those earthy minerals which are already proved to be of aqueous origin. That association is in some cases very accurate, because the metallic is imbedded in the earthy mineral; and thus the proof from nature is complete. It is twofold, however; the metallic mineral being either crystallized within an earthy crystallized one, as rutile is in quartz, or else disposed in strata of aqueous origin, such as shale and secondary limestone, that have not undergone the action of fire.

The natural proofs are not quite incontrovertible, when the metallic minerals are merely associated in the cavities of veins with those earthy ones which are of aqueous origin. Yet they are, perhaps, sufficiently strong; particularly when it is seen that many of these are, in reality, substances which, in other cases, carry much more decided proofs with them, either from other natural associations, or from chemical experiments and analogies. As the present remarks are not offered as including a series of positive facts on which a theory is to be erected, but merely as hints towards one, or as indicating the road that ought to be followed in attempting to explain the origin of mineral veins, any inaccuracies or doubtful particulars can be of no moment. The observations will answer all that is intended, if they turn the attention of mineralogists to a subject which ought to have been examined by those who have proposed or adopted theories of this nature; and who, in this case, seem to have proceeded by inverting the rules of philosophy. It will hereafter be seen that some minerals, both earthy and metallic, have a double origin, or are formed both from fusion and solution; so that perhaps in some of the cases here enumerated, some of these, such for example as those which are concluded to be aqueous from their association with carbonat of lime, may possibly be exclusively of igneous origin.

In examining the chemical evidence, it will be convenient to class the metallic minerals according to their leading relations of this nature, as it is not proposed to investigate every complicated species or variety which mineralogists have described. The following classification will answer the present purpose:

Metals; including the alloys.
Oxydes; whether simple or complicated.
Salts; comprising carbonats, sulphats, muriats, phosphats, arseniats, molybdats, tungstats, chromats and silicats; or combinations of more than one of these.
Sulphurets; simple or complicated.
Phosphurets.

We do not yet know how many metals can be separated from their solutions in a metallic state; but gold, silver, copper, and lead, can be procured in this manner with great facility. These may, therefore, be metals of an aqueous origin. Possibly this may happen to many others, from deoxydating processes in nature which we either have not examined, or which may be unattainable in our experiments.

All the metallic oxydes which involve a large number of these minerals, can be procured in the same manner; at least in a powdery state. If artificial chemistry has not yet contrived to obtain these in a crystallized form, it must be recollected that we cannot, like Nature, command the elements of time. Yet, perhaps, the case of oxydulous iron, which may be procured from the muriat by dissipating the acid, may be esteemed an instance in point; although the application of heat is necessary for this purpose. The oxyde appears here to crystallize at the moment of its separation from the acid, without the necessity of a dry or subliming heat, although it is not easy to ascertain the exact nature of this process.

If chemistry has not yet formed every complicated salt that is found in the list of metallic saline minerals, it has produced so many that we may, with little hazard of error, consider the aqueous process as fully competent to the production of the whole. That nature can exhibit some of them in a crystallized form, such as the phosphat of iron, for example, when we can only obtain them in our laboratories in a powdery one, must be referred to the cause just noticed; namely, the rapidity of our operations and the slowness of her's. As to the silicats, our acquaintance with the real nature of this combination, or the exact mode in which silica acts the part of an acid, is as yet so recent and imperfect, that no opinion can at present be given respecting them.

The igneous theory of metallic veins was supposed to be supported by an incontrovertible argument derived from the sulphuret of iron, which, it was asserted, could not possibly be formed from aqueous solution; and the same rule was in consequence extended to all the other sulphurets. We shall shortly see that nature does produce it from aqueous solutions abundantly. In the laboratory it can be procured, merely by allowing the serum of blood to stand for some time; and, it is also obtained from the decomposition of sulphat of iron by animal matters. There is little doubt that other metallic sulphurets may be formed in the same manner; and, it is a subject that requires to be further investigated by those who may have leisure for this purpose. These combinations can also be procured in the aqueous method, by means of sulphuretted hydrogen; a very probable agent in nature. In these latter cases the sulphurets are only obtained in a powdery form; but in the former the iron pyrites is crystallized.

Respecting the phosphurets, our direct experience is next to nothing; but it must be remarked at the same time, that this is at least a rare if not a doubtful modification of the metallic minerals. But the methods of decomposing the sulphuric and the phosphoric acids are so like, and all the points of analogy between sulphur and phosphorus are so strong, that it is safe to infer that phosphurets might be procured in the moist way as well as sulphurets.

In now examining the evidence which nature affords from the intimate association that exists between certain metallic minerals and those earthy ones which are ascertained to be of aqueous origin, it may be remarked that the chief of these latter are calcareous spar and quartz. Barytes and fluor are less conspicuous in this respect. The union with calcareous spar is rather more frequent than that with quartz; but, as these different earthy minerals frequently occur together, and particularly quartz and calcareous spar, it is not necessary to distinguish the metallic ones that seem to be in some cases peculiarly associated either with the one or with the other. The following list, therefore, contains those which are found in these associations, arranged according to their chemical natures, and under the most general terms.

Metals and Alloys.

Gold.
Silver.
Arsenical silver.
Iron.
Copper.
Arsenical Cobalt; (white cobalt).
Bismuth.
Tellurium.
Mercury and silver; (amalgam.)
Antimony.
Arsenical iron; (pyrites).
Arsenical nickel (kupfer nickel).

Oxydes.

Copper; black and red.
Iron; oxydulous. Hematite.
Lead; minium.
Titanium; rutile, anatase.
Arsenical oxyde.
Uranium; green and black.
Manganese; red and black.
Cobalt; red and black.

Salts.

Silver; muriat.
Copper; muriat, arseniat, phosphat.
Lead; phosphat, carbonat, sulphat, molybdat.
Iron; muriat, arseniat, carbonat, phosphat.
Tungsten; wolfram.
Zinc, carbonats.
Bismuth; carbonat.
Titanium; silicat. (Sphene).

SULPHURETS.

Silver.
Copper; yellow, grey.
Lead, lead and antimony.
Mercury; brown, red.
Iron.
Zinc.
Arsenic. Arsenic and iron.
Antimony; red and grey.
Bismuth.

The minerals which seem to carry the evidence of an aqueous origin in their forms are the following:

Earthy phosphat of iron.
Stalactitical hæmatites.
Bog iron ore.
Malachite.
Stalactitical manganese oxyde, red and black.
Stalactitical calamine.
Stalactitical pyrites, whether of iron or copper.

The last list is that which contains the minerals found in secondary strata of aqueous deposition, and which do not appear to have experienced the influence of fire.

Gold.
Quicksilver.
Muriat of quicksilver.
Sulphuret of quicksilver.
Blue carbonat of copper.
Green carbonat of copper.
Oxydulous iron.
Iron pyrites.
Hematites.
Iron stones and ochres.
Cobalt; black oxyde.
Manganese; black oxyde.

All of these are found in the preceding enumeration; so that these situations only offer proofs in confirmation of the present views.

I must now proceed to examine the minerals, whether earthy or metallic, which are the produce of igneous fusion, or of sublimation from a state of vapour. The evidence respecting these is also derived from two sources; from chemical experience, and from their positions in rocks which are known to be the produce of fire. These last may be limited to granite, the traps, and the volcanic rocks, though there seems no reason to doubt that gneiss, micaceous schist, and other primary strata might be added to these; in which case the catalogue might be still further increased.

The earthy minerals which may be modified by artificial fire, or which undergo the action of heat without destruction, are the carbonats of lime, barytes and strontian, and the phosphat of lime. Silica is sublimed in a crystalline form.

Of the metallic minerals it appears that every metal may be sublimed by artificial heat; and they all admit of being crystallized by fusion. All the sulphurets admit of being fused; all appear capable of being sublimed; and, probably the whole can also be produced in this way by a direct combination of their ingredients. All the oxydes are produced from the metals by heat, and some of them admit of being volatilized. Under these circumstances also, some of them crystallize; as was observed in red oxyde of copper, formed in the cavities of metallic vessels in Pompeii. It is probable that some of the metallic salts, the arseniats for example, can be produced in this way; but I cannot quote any satisfactory experiments on a subject which, in all its bearings, is well worthy the attention of those chemists who are interested in geology, and whose leisure is greater than my own.

In examining the evidence which nature affords on this question, the following is a list of such earthy minerals as are found in the situations above-mentioned. It is probable that many are omitted, as no evidence but what seemed unexceptionable has been taken; and, in examining the entire catalogue of minerals, it will easily be found that there are some of which the origin still remains uncertain, and which are therefore excluded both from the aqueous and the igneous lists.

Earthy Minerals.

Quartz (by fusion and by sublimation.)
Felspar.
Mica.
Hornblende.
Actinolite.
Chlorite.
Steatite.
Serpentine.
Chrysoberyl.
Epidote.
Apatite.
Pinite.
Idocrase.
Anthophyllite.
Andalusite.
Stilbite.
Jade.
Garnet.
Cyanite.
Zircon.
Fluor spar.
Spodumene.
Corundum.
Beryl.
Topaze.
Tourmalin.
Schorl.
Tremolite.
Emerald.
Gabbronite.
Wernerite.
Pyrophysalite.
Lapis lazuli.
Asbestus.

Fettstein.
Talc.
Opal.
Chrysoprase.
Hauyne.
Meonite.
Sommite.
Leucite.
Pseudosommite.
Pleonaste.
Hypersthene.
Diallage.
Augit.
Sahlite.
Peridot (by fusion, and by sublimation.)
Melilite.
Tabular spar.
Melanite.
Idocrase.
Ice spar.
Arragonite.

Together with some other volcanic minerals, which are yet ill defined.

The metallic minerals, thus found, are the following:

Copper.
Oxydulous iron.
Galena.
Graphite.
Chromat of iron.
Sphene.
Iron pyrites.
Oxyde of Tin.
Sulphuret of molybdena.

Such is the balance, as far as it yet appears possible to construct a tolerable list of this nature, between the aqueous and the igneous minerals. It would be highly improper, in the present state of things, to deduce from it any thing respecting a theory of mineral veins. For, though all the minerals of these were aqueous, or all igneous, we are equally at a loss to conjecture whence they came, and how they are so limited and so disposed as they are in veins. It might indeed be considered an argument in favour of an igneous theory, that the mines of Nagyag lie in volcanic rocks. But it is evident that this fact proves no more in this case than in that of granite or trap; since, in all of these rocks alike, aqueous infiltration takes place, as well into the veins as into the volcanic and trap amygdaloids.

But it is here worthy of remark, that of the earthy minerals actually found in mineral veins, there are more of an aqueous than of an igneous origin; although there are many more igneous than aqueous minerals in nature. With respect to the metallic ones, the difference is still more in favour of the aqueous minerals. That many of both kinds have a double origin, is only one out of the numerous difficulties that beset this subject. These are, in fact, such, and so apparently insurmountable at present, that a prudent geologist can do no better than suspend his judgment on the subject; provided he does not also suspend his investigations. Both the theories are before him, and he ought to try the facts by both, not by one only, to the exclusion of the other. In this pursuit, he ought to take into his views the formation of minerals by sublimation, and their production from infiltration; two processes which have been neglected by former theorists. Not, however, that these will, on either side, form in themselves a theory; because even were there not many more unintelligible circumstances in veins, we are still unable to explain whence, on either hypothesis, the minerals have arrived at their present places.

J. Mac Culloch.

Art. III. *Description of the Great Bandana Gallery, in the Turkey Red Factory of* Messrs. Monteith *and Co., at Glasgow.*

The benefits of liberal-mindedness are nowhere more fully displayed than in the modern advancement of our chemical arts. A quarter of a century ago, manufacturing chemists were wont to shroud their operations in mysterious secrecy, like the craftsmen of the dark ages, on a supposition, usually unfounded, of their being possessed of some wonder-working *recipes*, whose promulgation would be fatal to their interests. At that period, the monied proprietors of chemical factories were rarely practical chemists. They were, therefore, obliged to place entire dependance in certain operative adepts, whom they engaged at a considerable salary, to conduct their processes. These persons, having been previously employed as subordinate menials in some similar manufactory, had acquired a smattering notion of the routine of working: but, being entirely destitute of education, and having no general views concerning the business which they undertook to manage, they were perpetually falling into difficulties, and committing mistakes from time to time of the most ruinous description. Slight variations in the qualities and state of the materials employed, in the mode of mixture, in the temperature, or duration of the process, occasioned variations of result, which they could neither foresee, regulate, nor counteract; and, though the profits might be considerable on a successful operation, yet failures were so frequent and so expensive as to render the business not a little precarious and uncomfortable. Hence we can understand why chemical manufactories have undergone such vicissitudes of fortune,—some raising their proprietors to unexpected opulence, others sinking them to unlooked-for ruin.

The owners of chemical establishments, becoming at length impatient of the vassalage in which they had been long held by blundering and obstinate hirelings, began to inquire into the principles of their peculiar arts, and were thus led to cultivate the society of men of science. They now, for the first time, learned that economy and precision could be ensured to their processes only, by applying the same scientific rules which medical censorship, backed by the authority of law, had for a considerable time introduced with the happiest effect into the formerly mysterious and uncertain processes of pharmacy. Under this conviction, they consulted the chemical philosopher on their difficulties and disappointments. Suggestions, of greater or less value, were thus given and acted on, which led to new questions on the part of the manufacturer, and new researches on that of the chemist: and thus an alliance began between theory and practice, which has, in a very few years, carried several of the chemical arts of this country to an extraordinary pitch of perfection.

Instances have, undoubtedly, occurred of chemists of some reputation having given delusive advice to the manufacturer; as we see chemical authors publish, as processes of art, formulæ very disadvantageous and even absurd. These misdirections are almost always to be ascribed either to neglect of experimenting with due care on an adequate scale, or to superficial acquaintance with the principles of the science. It is very possible for a person to compile a dazzling series of class experiments with grandiloquent explications, without being either a philosophical or a practical chemist.

The league between science and art, which has, in this country, been the slow growth of necessity, was long ago effected in France, to a considerable extent, by authority of the government. The illustrious minister, Colbert, fraught with the most enlightened views of state policy, founded a school of science to superintend and assist the dyeing manufactories of the kingdom. From that school, conducted as it has been by a succession of eminent philosophers, have emanated invaluable researches on the most beautiful, but, at the same time, most intricate, of all the chemical arts,—researches to which France owes much of her eminence in this very profitable branch of her national industry.

The manufactory of Messrs. Monteith and Co. has been long celebrated in the commercial world for the excellence and beauty of its cotton fabrics. The madder-reds rival in brilliancy and solidity any ever produced at Adrianople; and the white figures, distributed over the cloth, surpass, in purity, elegance, and precision of outline, the original Bandana designs.

The opulent and enlightened proprietors have been careful to avail themselves of every resource which the latest improvements in chemistry and mechanics could supply. In this respect, their factory deserves to be studied as a school of practical science. The permission now granted of describing their discharging-gallery is a proof of their liberality, as well as of the confidence justly entertained, that the capital and skill, now engaged in their establishment, are better securities for the preference which their goods possess in the European market, than the utmost mystery in conducting their processes.

Hence they have rarely refused to strangers, respectable for their rank or science, permission to visit their manufactory,—a favour which it is impossible to enjoy without being gratified and instructed.

Their new arrangement of hydrostatic presses was completed in 1818, under the direction of Mr. George Ridger, senior, manager of the works. It consists of sixteen of these engines beautifully constructed, placed in one range in subdivisions of four; the spaces between each set serving as passages to admit the workmen readily to the back of the press. Each subdivision occupies twenty-five feet; whence the total length of the apparatus is one hundred feet.

To each press is attached a pair of patterns in lead, (or *plates* as they are called,) the manner of forming which will be described in the sequel. One of these plates is fixed to the upper block of the press. This block is so contrived that it turns on a kind of universal joint, which enables this plate to apply more exactly to the under plate. The latter rests on the moveable part of the press, commonly called the *sill.* When this is forced up the two patterns close on each other very nicely by means of guide-pins at the corners, fitted with the utmost care.

The power which impels this great hydrostatic range is placed in a separate apartment, called the *machinery-room.* This machinery consists of two cylinders of a peculiar construction, having cylindric pistons accurately fitted to them. To each of these cylinders three little force-pumps, worked by a steam-engine, are connected.

The piston of the larger cylinder is eight inches in diameter, and is loaded with a top-weight of five tons. This piston can be made to rise about two feet through a leather stuffing or collar. The other cylinder has a piston of only one inch in diameter, which is also loaded with a top-weight of five tons. It is capable, like the other, of being raised two feet through its collar.

Supposing the pistons to be at their lowest point, four of the six small force-pumps are put in action by the steam-engine, two of them to raise the large piston, and two the little one. In a short time, so much water is injected into the cylinders, that the loaded pistons have arrived at their highest points. They are now ready for working the hydrostatic discharge-presses, the water pressure being conveyed from the one apartment to the other under ground through strong copper tubes of small calibre.

Two valves are attached to each press, one opening a communication between the large *prime-cylinder* and the cylinder of the press, the other between the small *prime-cylinder* and the press. The function of the first is simply to lift the under-block of the press into contact with the upper-block; that of the second is to give the requisite compression to the cloth. A third valve is attached to the press, for the purpose of discharging the water from its cylinder, when the press is to be relaxed, in order to remove or draw through the cloth.

From twelve to fourteen pieces of cloth, previously dyed Turkey-red, are stretched over each other, as parallel as possible, by a particular machine. These parallel layers, are then rolled round a wooden cylinder, called by the workmen, a drum. This cylinder is now placed in its proper situation at the back of the press. A portion of the fourteen layers of cloth, equal to the area of the plates, is next drawn through between them, by hooks attached to the two corners of the webs. On opening the valve connected with the eight inch *prime-cylinder*, the water enters the cylinder of the press, and instantly lifts its lower block, so as to apply the under plate with its cloth, close to the upper one. This valve is then shut, and the other is opened. The pressure of five tons in the one inch *prime-cylinder*, is now brought to bear on the piston of the press, which is eight inches in diameter. The effective force here will, therefore, be 5 tons $\times 8^2 = 320$ tons; the areas of cylinders being to each other, as the squares of this respective diameters. The cloth is, therefore, condensed between the leaden pattern-plates, with a pressure of 320 tons.

The next step, is to admit the blanching or discharging liquor, (aqueous chlorine, obtained by adding sulphuric acid to solution of chloride of lime,) to the cloth. This liquor is contained in a large cistern, in an adjoining house, from which it is run at pleasure into small lead cisterns attached to the presses; which cisterns have graduated index tubes, for regulating the quantity of liquor according to the pattern of discharge. The stopcocks on the pipes and cisterns containing this liquor, are all made of glass.

From the measure-cistern, the liquor is allowed to flow into the hollows in the upper lead-plate, whence it descends on the cloth, and percolates through it, extracting in its passage, the Turkey red dye. The liquor is finally conveyed into the waste pipe, from a groove in the under block. As soon as the chlorine liquor has passed through, water is admitted in a similar manner, to wash away the chlorine; otherwise on relaxing the pressure, the outline of the figure discharged, would become ragged. The passage of the discharge liquor, as well as of the water through the cloth, is occasionally aided by a pneumatic apparatus, or blowing machine; consisting of a large gasometer, from which air subjected to a moderate pressure, may be allowed to issue, and act in the direction of the liquids, in the folds of the cloth. By an occasional twist of the air stopcock, the workman also can ensure the equal distribution of the discharging liquor, over the whole excavations in the upper plate. When the demand for goods is pressing, the air apparatus is much employed, as it enables the workman to double his product.

The time requisite for completing the discharging process in the first press, is sufficient to enable the other three workmen to put the remaining fifteen presses in play. The *discharger* proceeds now from press to press, admits the liquor, the air, and the water; and is followed at a proper interval by the assistants who relax the press, move forwards another square of the cloth, and then restore the pressure. Whenever the sixteenth press has been liquored, &c., it is time to open the first press. In this routine, about ten minutes are employed; that is 224 handkerchiefs (16 × 14) are discharged in ten minutes. The whole cloth is drawn successively forward, to be successively treated in the above method.

When the cloth escapes from the press, it is passed between two rollers in front; from which it falls into a trough of water placed below. It is finally carried off to the washing and bleaching department, where the lustre of both the white and the red is considerably brightened.

By the above arrangement of presses, 1600 pieces, consisting of 12 yards each = 19,200 yards, are converted into Bandanas in the space of ten hours, by the labour of four workmen.

The patterns, or plates, which are put into the presses to determine the white figures on the cloth, are made of lead, in the following way. A trellis frame of cast-iron, one inch thick, with turned-up edges, forming a trough rather larger than the intended lead pattern, is used as the solid groundwork. Into this trough, a lead plate about one half inch thick, is firmly put by screw nails passing up from below. To the edges of this lead plate, the borders of the piece of sheet-lead are soldered, which covers the whole outer surface of the iron frame. Thus a strong trough is formed, one inch deep. The upright border gives at once great strength to the plate, and serves to confine the liquor. A thin sheet of lead, is now laid on the thick lead-plate, in the manner of a veneer on toilette-tables, and is soldered to it, round the edges. Both sheets must be made very smooth beforehand, by hammering them on a smooth stone table, and then finishing with a plane: the surface of the thin sheet (now attached), is to be covered with drawing paper pasted on, and upon this, the pattern is drawn. It is now ready for the cutter. The first thing which he does, is to fix down with brass pins, all the parts of the pattern, which are to be left solid. He now proceeds with the little tools generally used by block cutters, which are fitted to the different curvatures of the pattern, and he cuts perpendicularly quite through the thin sheet. The pieces thus detached are easily lifted out; and thus, the channels are formed, which design the white figures on the red cloth. At the bottom of the channels, a sufficient number of small perforations are made through the thicker sheet of lead, so that the discharging liquor may have free ingress and egress. Thus, one plate is finished; from which, an impression is to be taken by means of printers' ink, on the paper pasted on another plate. The impression is taken in the hydrostatic press. Each pair of plates constitutes a set, which may be put into the presses, and removed at pleasure.

Plate VI. is an elevation of one press; A, the top, or entablature; BB, cheeks of ditto, or pillars; C, upper block for fastening upper pattern to; D, lower or moveable block; E, the cylinder; F, the sole or base; G, the water trough for the discharged cloth to fall into; H, cistern or liquor-metre; dd, glass tubes for indicating the quantity of liquor in the cistern; ee, glass stop-cocks for admitting the liquor into the cistern; ff, stop-cocks for admitting water; gg, the pattern-plates; nn, screws for setting the patterns parallel to each other; mm, snuffs perforated with a half inch drill. The lower iron frame has corresponding pins, which suit these perforations, so that the patterns are guided into exact correspondence with each other; hh, rollers which receive and pull through the discharged cloth, from which it falls into the water-box; k, stop-cock for filling the trough with water; i i i, waste tubes for water and liquor.

Glasgow, May 30*th*, 1823.

ART. IV. LAMARCK's *Genera of Shells.*

[Continued from Vol. XV. p. 52.]

CLASS XII.

MOLLUSCA*.

ANIMAL soft, not articulated, having a head, which forms a fleshy eminence on the fore part of the body, more or less prominent, often of a round shape and generally furnished with eyes, and sometimes, with from two to four, or at most, six tentacula; sometimes surmounted by arms on the summit, disposed in the form of a crown. Mouth, whether short or elongated, tubular, exsertile, and usually armed with hard parts. Mantle various, either with the margins free, at the sides of the body, or with the lobes united into a bag which partly envelopes the animal.

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* *Molluscus soft*; an old word, nearly obsolete, derived from the Greek μαλακος.

Branchiæ various, rarely symmetrical, circulation double, one particular, the other general. Heart unilocular, occasionally with two divided, very remote auricles. No ganglionated medullary cord, but a few dispersed ganglia, and different nerves.

Body sometimes naked, either with no internal solid parts, or enclosing a shell, or some hard substance; sometimes furnished with an external covering, or ensheathing univalve shell. Shell never composed of two opposite valves united by a hinge.

The distinguishing character of the mollusca, is that they have no vertebræ, are wholly without articulations in all their parts, and have a more or less prominent head at the anterior portion of the body.

The body of these animals is fleshy, soft, and eminently contractile, and endowed with the power of reproducing the parts that may have been destroyed. It is covered with a soft skin, moistened by a viscous glutinous fluid, which continually exudes from it; the skin forms the true covering of the animal, and is wholly independent of the solid testaceous envelope. The blood of the mollusca is white or bluish; their muscles are white and very irritable, attached beneath the skin to the substance of the mantle. The body is elongated, sometimes oval, slightly depressed, sometimes straight, and sometimes spiral at the hinder part. They have no true lungs, but respire by the branchiæ. Their mouth is generally furnished with hard parts; in some it is short, and has two jaws; in others, it consists of a retractile trunk, with small teeth at its internal orifice, but no jaws. The mollusca, which are furnished with the trunk, as the buccina, volutæ, *&c.*, are carnivorous, using it to perforate the shells of other shell-fish, in order to prey on the animal within. Those with strong horny jaws, (the cephalopoda,) shaped like a parrot's bill, also live on animal food. The limaces, helices, bulimi, and all that have cartilaginous jaws, furnished with very minute teeth, almost invisible, but sensible to the touch, live on herbs or fruits.

The foot consists of a fleshy, muscular, and glutinous disk; it serves the animal to crawl with, and is placed at the lower surface of the body, either on the fore part, or extending through its whole length. The crawling foot is peculiar to the gasteropoda and the trachelipoda. The mollusca, which have non-operculated shells, have but one muscle of attachment, situated near the middle of the back; those with opercula have two, one which connects the animal with the shell, the other belonging to the operculum. The operculum is usually round, solid, horny or calcareous, and serves to close the mouth of the shells when the animal is in a state of repose; when it comes out of the shell, it carries the operculum with it, and on retiring it re-adjusts this natural door to the entrance of its dwelling*. Some mollusca are naked, that is, have no external shell, and are quite soft in all their parts—others, though naked without, are provided with one or more solid bodies internally, which sometimes are simply cartilaginous or horny, sometimes cretaceous and lamellar, constituting a true internal shell. This shell is usually spiral, and its cavity simple or undivided, as in the bullææ, bullæ, sigareti, *&c.*, but in many of the cephalopoda, it is multilocular, its cavity being divided into several regular chambers, by transverse partitions.

Other mollusca have shells, which are wholly external.

The mollusca are in general aquatic animals. Most of them inhabit the sea; others live in fresh water; and others, again, in moist, shady places, on land. Some of the latter, however, are capable of supporting the heat of a brilliant sunshine.

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* The helix pomatia has a very solid, calcareous operculum; with which it firmly closes the mouth of its shell at the approach of winter. The wonderful rapidity with which the animal secretes the matter to form this external defence, is strikingly exhibited in the following experiment, communicated by Mr. Henry Stutchbury. This gentleman and his brother, took a helix pomatia on a warm summer's day, when it was quite destitute of any operculum, (for it casts it off at that season,) and placed it in a vessel, surrounded by a freezing mixture. In the short space of twelve hours it formed a complete solid operculum, in every respect similar to the natural one, except that it was not quite so thick.—*Tr.*

This class is divided into the five following orders:

First Order.

PTEROPODA *.

No foot, or arm, for crawling or seizing its prey. Two opposite and similar fins, (nageoires,) adapted for swimming. Body free, floating.

Second Order.

GASTEROPODA †.

Body straight, never spiral, nor enveloped in a shell capable of containing the whole of it. Foot muscular, united to the body nearly through its whole length, situated under the belly, and formed for crawling.

Third Order.

TRACHELIPODA ‡

Body in great measure spiral, separate from the foot, and always covered by a spirivalve shell. Foot free, flat, attached to the inferior base of the neck, and formed for crawling.

Fourth Order.

CEPHALOPODA §.

Body, except the head, contained in a bag-shaped mantle. Head projecting beyond the bag, crowned with inarticulated arms, furnished with air-holes, and surrounding a mouth with two horny mandibles.

Fifth Order.

HETEROPODA ‖.

No coronet of arms on the head; no foot, for crawling, under the belly or neck. One or more fins, not disposed in pairs, or regular order.

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* From ϖτερον, a wing, and ϖȣς, a foot.
† From γαστηρ, the belly, and ϖȣς, a foot.
‡ From τραχηλος, the neck, and ϖȣς, a foot.
§ From κεφαλη, the head, and ϖȣς, a foot.
‖ From ἑτερος, different, and ϖȣς, a foot.

First Order.

PTEROPODA.

Most of the Pteropoda are small animals, with no appendices, or only very short ones on the head. Some have a thin cartilaginous or horny shell, and some have branchial fins.

1st Family.

HYALÆANA. (6 Genera.)

1. Hyalæa [*].

Body covered with a shell; two opposite, rather large, retractile fins inserted at each side of the mouth. Scarcely any head. Mouth terminal, situated at the junction of the fins. No eyes. Branchiæ lateral. Shell horny, transparent, ovate-globular, posteriorly tridentate, open at the summit and two posterior sides.

The shell of the Hyalæa appears, according to Forskahl, to consist of two valves cemented together. The valves are unequal; the largest, dorsal, rather flattened below, the other ventral, tumid, subglobular, and shortened anteriorly. The middle one of the three posterior teeth, or points, is perforated. On each side of the shell, is a very open fissure, to admit the water to the branchiæ.

Type. *Hyalæa tridentata* [†]. (Monoculus telemus? *Linn.*)

Shell yellowish, pellucid, thin, very delicately striated transversely; terminal point longer than the lateral.

Mediterranean. 2 Species. Pl. VII. Fig. 106 [‡].

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[*] From ὑαλος, *glass.*

[†] *Having three teeth.*

[‡] We have given a figure of another, and, we believe, hitherto unpublished, genus, which seems to belong to this family. It was collected by the late Mr. Cranch, on the Congo Expedition, and presented to the British Museum, (where it is preserved, with another species, apparently of the same genus,) by the Lords Commissioners of the Admiralty. We propose to call it, at the suggestion of a kind and learned friend, *Balantium recurvum* [a]. As the animal inhabitant, however, is quite unknown to us, we place it in this family, merely from the strong analogy which the

[a] From Βαλαντιον, a purse; *recurvum, recurved*—the apex being bent.

2. Clio.

This genus has no shell.

3. Cleodora.

Body oblong, gelatinous, contractile, bi-alate; the head on the anterior part of the body, the posterior covered with a shell. Head projecting, very distinct, rounded, with two eyes, and a small subrostrated mouth. No tentacula. Two opposite membranous, transparent, cordate *alæ* *, inserted at the base of the neck.

Shell straight, gelatino-cartilaginous, transparent, in the form of a reversed pyramid, lanceolate, truncated and open at the top.

These animals, like the rest of the Pteropoda, float at random, in the sea.

Type. *Cleodora pyramidata* †. (Clio pyramidata. *Linn.*)

Shell triangular, pyramidal, short; mouth obliquely truncated. *American Ocean.* 2 species. Pl. VII. Fig. 108.

4. Limacina ‡.

Body soft, oblong, anteriorly very similar, in regard to the head and alæ, to the clio; but spirally contorted, at the hinder part, and enclosed in a shell.

Shell thin, brittle, papyraceous, spiral; turns of the spire united in a discoidal order, like the planorbis.

The limacina is ill named, for it rather resembles a helix than a limax; but the shell being flattened on the upper part,

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substance of the shell bears to that of the Hyalæa, until an opportunity may occur of obtaining more accurate information respecting this interesting species. It may be described as follows.

Shell transparent, very thin and fragile, hyaline, corneous, hastiform, apex recurved; open at both ends; superior aperture dilated, sharp edged; inferior round, very minute; sides acute; superior disk undulated; inferior rounded; numerous transverse grooves on both sides. P. VII. Fig. 107. The figure given (Plate vii. No. 8.) in Mr. Parkinson's *Introduction to the Study of Fossil Organic Remains*, as a Hyalæa, very much resembles the other species of this genus, alluded to above.

* Wings. Two membranes, situated as described in the text, which, when extended, serve as sails, whilst the animal is floating on the surface of the water.

† *Pyramidal.*

‡ From *limax*, a *snail.*

from the whorls being united in a discoidal form, makes it still more like a planorbis. It differs from the Cleodora, merely by being spiral.

One Species. *Limacina helicialis*[*]. (Clio helicina. *Gmel.*)

North Seas. Whales are said to prey on the Limacina.

5. Cymbulia[†].

Body oblong, gelatinous, transparent, enclosed in a shell. Head sessile[‡]; two eyes; two retractile tentacula; mouth furnished with a retractile trunk. Two opposite, rather large, rounded oval, branchiferous alæ, connected, at the posterior base, by an intermediate, lobe-shaped appendix.

Shell gelatino-cartilaginous, very transparent, crystalline, oblong, in shape like a shoe, truncated at the summit; aperture lateral, anterior.

One Species. *Cymbulia peronii*[§].

Mediterranean, near Nice. Length about two inches. Pl. VII. Fig. 109.

6. Pneumodermon[||].

This genus has no shell.

Second Order.

GASTEROPODA. (Contains 7 Families.)

Body of the animal straight, never spiral, nor enveloped by a shell, capable of containing it wholly; a foot, or muscular disk under the belly, united to the body nearly through its whole length, and used in crawling.

Some of the individuals of this order are naked, others have a dorsal, but not enveloping shell, and others have an internal shell, more or less hid under the mantle.

The Gasteropoda are divided into seven families; viz., Tritoniana, Phyllidiana, Semi-Phyllidiana, Calyptraciana, Bullæana, Laplysiana, and Limaciana. None of the animals of the first family have any shell; we proceed, therefore, to the

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[*] *Resembling a helix.*

[†] From *cymbula*, a *little boat*.

[‡] That is, without any distinct neck.

[§] Of *M. Péron*.

[||] From ϖνευμων, the lungs, and δερμα, the skin.

2d Family.

PHYLLIDIANA, (4 genera.)

Branchiæ situated under the border of the mantle, and disposed in a longitudinal series round the body. The individuals of this family respire water only.

Some of the Phyllidiana have no shell, either external or internal; others are wholly, or in part, covered by a shell, sometimes composed of one single piece, sometimes of a range of moveable and distinct pieces.

1. Phyllidia.

This genus has no shell.

2. Chitonellus [*].

Body creeping, elongated, rather narrow, resembling a caterpillar; a multivalve shell on the middle of the back, through its whole length, like a riband; valves alternate, longitudinal, almost connected by their extremities; sides of the back naked. Branchiæ disposed like those of the Chitones; foot divided longitudinally by a deep furrow.

The valves of the shell, whilst the animal is alive, are separate; but, when dead and contracted, several of them appear to be united. The Chitonellus is nearly allied to the Chiton; but the looser disposition of the dorsal shell admits of greater freedom of motion to the right or left, and suffers the animal to bend its body to either side with facility, like a worm. The longitudinal furrow in the foot, probably serves for crawling on the stems of marine plants.

Type. *Chitonellus lævis* [†].

Shell with smooth small valves; margins very entire; last valve pointed posteriorly.

New Holland. 2 Species. Pl. VII. Fig. 110.

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[*] Little *Chiton.* [†] *Smooth.*

3. Chiton [*].

Body creeping, oval oblong, convex, rounded at the extremities, bordered all round by a coriaceous skin, and partly covered by a longitudinal series of testaceous, imbricated, transverse, moveable pieces, connected with the borders of the mantle. Head anterior, sessile; mouth situated at the lower part, covered by a membrane, and furnished with numerous teeth, some simple, some with three points, and disposed in several longitudinal rows. No tentacula nor eyes. Branchiæ disposed in series round the whole body under the border of the skin; anus below the posterior extremity.

The shell of the Chiton is generally composed of eight valves, sometimes of seven, or only six; the middle valves are rather larger than those at the extremities. They live in the sea at moderate depths, and near the shore; attaching themselves, but not permanently, to rocks and stones.

Type. *Chiton squamosus* [†]. (Idem. *Linn.*)

Shell with eight valves, semistriated; body covered with small scales.

Mediterranean, and American Seas. Six Species. Pl. VII. Fig. 111.

4. Patella [‡].

Body entirely covered by an univalve shell; two pointed tentacula on the head, with eyes at their exterior base. Branchiæ disposed in series all round the body, under the border of the mantle; anus and orifice for generation at the right anterior side.

Shell univalve, not spiral, enveloping, clypeiform, or flattened conical, concave and simple below; no fissure in the margin; summit entire, inclining to the anterior side.

The summit is often the thickest part of the shell, and the muscular attachment is very perceptible, on the concave side, in many of the species; and shews that the head of the animal is always placed on the side towards which the summit inclines.

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[*] χίτων, a *coat of mail.*

[†] *Scaly.* Lamarck's second Species. His type is *C. gigas.*

[‡] A *small deep dis*

The Patellæ are widest at the posterior side, and the periphery of the shell is usually oval. They seem to live habitually in the same place, though they probably have the power of changing their situation from time to time.

Linnæus or Gmelin classed the fissurella, emarginula, navicella, umbrella, pileopsis, calyptræa, and crepidula, all under the genus Patella.

Most of the Patellæ have ribs, radiating from the summit to the margin.

Type. *Patella granatina*[*]. (Idem, *Linn.*)

Shell angular, with numerous ribs and striæ; apex, both within and without, purplish black. *Antilles.* 45 species. Pl. VII. Fig. 112.

3d Family.

SEMI-PHYLLIDIANA. (2 genera.)

Branchiæ situated under the border of the mantle, and disposed in a longitudinal series, on the right side only of the body. The animals breathe water.

In the disposition of the branchiæ, the mollusca of this family have considerable resemblance to those of the preceding, except that in the Phyllidiana they occupy the whole of the canal, which encircles the body between the border of the mantle and the foot, whilst in the Semi-Phyllidiana they are found only in that *half* of the canal which lies on the right side,—whence the name. In other respects, the two families differ considerably; but, since the branchiæ are not placed, as in the succeeding families, in an insulated cavity, Lamarck has thought it necessary to assign them a distinct rank, in the order of the Gasteropoda.

1. Pleurobranchus[†].

Body crawling, fleshy, oval-elliptic, covered by a projecting mantle; foot large and projecting like the mantle, so that the two form an intermediate canal, and the body appears as if enclosed between two equal shields. Branchiæ on the right side, inserted in the canal, and disposed in series, on the two faces of a longitudinal lamina. Mouth anterior, proboscis-shaped, situated underneath. Two cylindrical, hollow tentacula, with an external longitudinal fissure, attached to the lamina which covers the mouth. Aperture of the organs of generation in front of the branchial lamina; anus behind; both on the right side.

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[*] *Garnet-coloured.*

[†] From ϖλευρα *the side*, and βραγχια, *branchiæ, the lungs with which fishes breathe.*

Shell internal, dorsal, thin, flattened, often oblique-oval.

One species. *Pleurobranchus Peronii.*

No further description.

Indian Seas. Pl. VII. Fig. 113.

2. Umbrella.

Body very thick, subovate, furnished with a dorsal shell; foot very large, prominent, smooth and flat on the under part, notched before, posteriorly attenuated. Head not distinct; mouth at the bottom of a funnel-shaped cavity, situated in the anterior sinus of the foot. Four tentacula; two superior, thick, short, truncated, with a fissure on one side, internally, transversely sublamellar; two others thin, cristate, pedunculated, inserted at the sides of the mouth. Branchiæ foliaceous, arranged in series between the foot and the border of the mantle, through the whole length of the right side, both anterior and lateral. Anus behind the posterior extremity of the branchiæ.

Shell external, orbicular, rather irregular, almost flat, slightly convex above, white; apex small, near the middle; margin sharp; internal face slightly concave, presenting a callous, colourless disk, depressed in the centre, and surrounded by a smooth border.

M. de Blainville, who has described the animal of the umbrella under the name of *gastroplax*, says, that its "shell has been found adhering to the inferior face of the animal." M. Mathieu, however, who has seen the species alive, at the Isle of France, asserts that the shell is dorsal.

Type. *Umbrella Indica* †. (Patella umbellata, *Gmel.*)

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* Our figure is copied from that in the *Annales du Muséum.* V. Pl. XVIII. Fig. 1 and 2.

† *Indian umbrella*, commonly called the *Chinese parasol.*

Shell somewhat concave, on the under side thin, and slightly transparent; disc divided by radiating striæ.

Indian Ocean, and common at the Isle of France. 2 Species. Pl. VII. Fig. 114.

4th Family.

CALYPTRACIANA. (7 Genera.)

Branchiæ placed in a cavity on the back, near the neck, and projecting either in the cavity itself, or beyond it. The animals breathe only water.

Shell always external, covering.

The animals of this family, in respect of form and position of their shell, are nearly allied to the phyllidiana, especially the patellæ; but the situation of their branchiæ, in an insulated cavity on the back near the neck, sufficiently distinguishes them from the individuals of that family, and requires that they should be placed in a separate group. None of the shells belonging to the Calyptraciana are operculated, wherefore the navicella is decidedly excluded from this family. The seventh genus, ancylus, is placed in it for the present, till the organization of its animal inhabitant shall be more fully known.

1. Parmophorus [*].

Body crawling, very thick, oblong-oval, rather widest at the posterior end, obtuse at the extremities; mantle, cleft in front, falling vertically over the body, and covered by a scutiform shell. Head distinct, situated under the cleft of the mantle, with two conical, contractile tentacula, with two eyes at their external base. Mouth below, hid in an obliquely truncated funnel. Branchial cavity opening anteriorly, but behind the head by a transverse fissure, and containing two lamellar, pectinate, projecting branchiæ. Orifice of the anus in the branchial cavity.

Shell oblong, subparallelopipedal, rather convex above, retuse at the extremities, anteriorly emarginate, sinus slight, apex small, inclining to the posterior side. Lower surface slightly concave.

Type. *Parmophorus australis* [†].

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[*] From ϖαρμη, *a shield*, and φερω, *to bear.*

[†] *Southern.*

Shell solid, smooth; of the same length as the back of the animal; margin rather thick.

New Holland. Pl. VII. Fig. 115. 4 Species.

2. Emarginula*.

Body creeping. Two conical tentacula, with eyes at their external base; mantle very large, partly covering the shell with its folds; foot broad, and very thick.

Shell scutiform, conical; vertex inclined; cavity simple; posterior margin notched, or emarginate.

The shells of this genus are generally small; some of them are considerably convex, in form of a cone, inclined towards the anterior margin, which is always the narrowest, and opposite to that which has the fissure. In others, the cone is very much flattened, and scarcely perceptible.

Type. *Emarginula fissura* †. (Patella fissura, *Linn.*)

Shell oval, convex-conical, decussated with longitudinal ribs and transverse striæ, pellucid, whitish; vertex curved; margin crenate.

European seas. Pl. VII. Fig. 116. 2 recent species, and 3 fossil.

3. Fissurella‡.

Head of the animal truncated anteriorly. Two conical tentacula, with eyes at their external base; mouth terminal, simple, without jaws. Two pectinate branchiæ projecting from the branchial cavity on each side of the neck; mantle very ample, projecting beyond the shell; foot wide, very thick.

Shell scutiform, or depressed conical; concave on the under side; vertex perforated; foramen oval, or oblong; no spire.

Some of the Fissurellæ are of considerable size and thickness. The hole on the summit is never round.

Type. *Fissurella nimbosa* §. (Patella nimbosa, *Linn.*)

Shell ovate-oblong, convex, brownish white, with violet-brown rays; longitudinal striæ numerous, crowded; margin crenate; foramen oblong.

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* Derived, we suppose, from *emarginatus*, in allusion to the fissure in the posterior mergin.

† A *fissure.*

‡ Dim. from *fissura, a little fissure.*

§ *Cloudy.* Lamarck's second species; his type is *F. picta.*

South of Europe. Pl. VII. Fig. 117. 19 recent species, and 1 fossil.

4. Pileopsis*.

Shell univalve, oblique-conical, curved forwards; summit bent, almost spiral; aperture rounded oval; anterior margin shortest, acute, terminating in a slight sinus; posterior margin larger, round; an elongated, arched, transverse muscular impression under the posterior border.

Animal.—Two conical tentacula, with eyes at their external base. Branchiæ disposed in a row under the anterior border of the cavity, near the neck.

According to M. Defrance, it is probable that the animal of this species never removes itself from the place where it has once fixed. He observed, in some fossil species, a support formed for the shell, during the life of the animal, by successive depositions of testaceous matter, constituting a separate piece, attached to marine substances, and preserving, on its upper part, a pretty deep impression of the margin of the shell.

Lamarck subdivides this genus into, 1, Shells without any known support; and, 2, Shells with a support†. The first subdivision contains eight species, the second two. Only the first four species of the first subdivision are recent shells, all the rest are fossil.

Type. *Pileopsis ungarica*‡. (Patella ungarica. *Linn.*)

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* From ϖιλος, a *bonnet*, and οψις, *appearance*, denoting the bonnet shape of the shell.

† In the first number of his Genera of recent and fossil shells, Mr. G. B. Sowerby gave his reasons for considering the *Hipponix* of De France (Pileopsis of the second subdivision, *Lamarck*) to be a true bivalve shell, the "*support*" being, in fact, the lower valve; and in the 15th number, just published, he adds the following additional arguments in confirmation of his opinion: "Lamarck's *Calyptraciens* are *Gasteropodes;* the shell being a testaceous deposition from the mantle, and the Gasteropodes, not being furnished with such a mantle under their foot, could not possibly deposit testaceous matter in such a position, as to form what he has termed a support, but which should more properly be called another valve; consequently, his 'Cabochons ayant un support connu' should be placed among the Conchifera, or we must suppose the absurdity of a *Gasteropoda* depositing shelly matter from the lower part of its foot, where it is not furnished with the necessary organs."—This appears to us to be perfectly conclusive.

‡ *Hungarian.*

Shell pointed, conical, striated; vertex curved, involute; aperture widest in the transverse direction, internally rose-coloured.

Mediterranean. Pl. VII. Fig. 118. 10 Species.

5. Calyptræa.

Animal unknown.

Shell conoidal, vertex erect, imperforate, subacute; base orbicular. Cavity furnished with an attached, convolute lamina, or spiral diaphragm.

Type. *Calyptræa equestris*[*]. (Patella equestris. *Linn.*) Shell suborbicular, convex-conical, thin, pellucid, white, with acute, undulated, subtuberculated, longitudinal striæ, increasing in size towards the margin; vertex subacute, curved. *Indian Ocean.* Pl. VII. Fig. 119.

6. Crepidula[†].

Animal......head forked anteriorly. Two conical tentacula, with eyes at their external base. Mouth simple, without jaws, and placed at the bifurcation of the head. Branchia single, subpenicillate, projecting beyond the branchial cavity, on the right side of the neck. Mantle never extending beyond the shell. Foot very small. Anus lateral.

Shell oval or oblong, convex externally, internally concave; spire very much inclined towards the margin; aperture partly closed by a horizontal lamina.

The shell of the crepidula not only covers the animal, but partly ensheathes it, for the chamber, formed by the lamina, always contains a portion of its body. It has no operculum. Found on rocks near the sea-side.

Type. *Crepidula fornicata*[‡]. (Patella fornicata. *Linn.*) Shell oval, posteriorly obliquely curved; posterior lip concave. *Barbadoes.* Pl. VII. Fig. 120. 6 species.

7. Ancylus[§].

Body creeping, wholly covered by the shell. Two compressed, slightly truncated tentacula, with eyes at their internal base. Foot short, elliptical, rather narrower than the body.

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[*] *Equestrian.* Lamarck's third species. His type is *C. extinctorium.*

[†] Dim. from *crepida,* a *little shoe.*

[‡] Arched.

[§] Is this a corruption of *ancile* or *ancilium*, a *sacred shield?* We can find no such word as *ancylus.* But this is not the only instance in which our author's Latin names are somewhat difficult to translate.

Shell thin, obliquely conical; summit pointed, inclined backwards; aperture oval; margin very simple.

Type. *Ancylus lacustris*[*]. (Patella lacustris. *Linn.*)

Shell semiovate, membranaceous; vertex subcentral; aperture suboblong-ovate. *France.* Pl. VII. Fig. 121. 3 Species.

5th Family.

Bullæana. (3 Genera.)

Branchiæ situated in a cavity, near the posterior part of the back, and covered by the mantle. No tentacula.

1. Acera.

This genus has no shell.

2. Bullæa[†].

Body elongated oval, slightly convex above, divided transversely into an anterior and a posterior part. Lateral lobes of the foot, with rather a thick border, and reflected upwards. Head scarcely distinct. No tentacula. Branchiæ dorsal, situated under the posterior portion of the mantle. Shell concealed in the mantle, above the branchiæ, and not adhering to the animal by any muscular attachment.

Shell very thin, partially convolute, and spiral on one side; no columella, nor projecting spire; aperture very large, dilated at the upper part.

One Species. *Bullæa aperta*[‡] (Bulla aperta. *Linn.*)

The last whorl of the volute, is terminated by the right margin of the aperture. *European Seas.* Pl. VII. Fig. 122.

3. Bulla[§].

Body oblong-oval, slightly convex, divided at the upper part into two transverse portions; mantle posteriorly plicate. Head very indistinct. No apparent tentacula. Branchiæ dorsal, posterior; covered by the mantle. Anus on the right side. Posterior part of the body covered by an external shell, adhering by a muscular attachment. Shell univalve, oval-globular, convolute; no columella, nor projecting spire, or only very slightly elevated; aperture the whole length of the shell; right margin acute.

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[*] Of *the pools.*

[†] *As nearly allied to the bulla.*

[‡] *Open.*

[§] *A bubble.*

The bulla differs from the bullæa, by the shell being completely convolute, always visible externally, and only partially covered by the hinder part of the animal, which adheres to it by a muscular attachment. The animal even hides completely in the shell. In the bullæa the shell is imperfectly convolute, wholly concealed by the posterior part of the mantle, but not affixed to it, and not at all visible externally.

The genus bulla of Linnæus was very vague and inconveniently extensive, as is evident from his *B. ovum, achatina, ficus, terebellum*, &c., shells which belong to very different genera and even families. Bruguière reformed the genus, and distinguished it clearly from the *ovulæ*, but he left the *bullæa* in it, which Lamarck has since separated. The bullæ are generally ventricose shells.

Type. *Bulla lignaria**. (Idem. *Linn.*)

Shell oblong, loosely convolute, attenuated towards the spire, transversely striated, pale yellow; spire truncated; umbilicated. *European Seas.* Pl. VII. Fig. 123. 11 Species.

6th Family.

LAPLYSIANA. (2 Genera.)

Branchiæ placed in an appropriate cavity, near the posterior part of the back, and covered by an opercular scutcheon. Tentacula.

The Laplysiana resemble large limaces, but their body is broader, and larger towards the posterior part, and the borders of the mantle are more ample. The head projects considerably forward, and has four tentacula, two near the mouth, and two behind. The latter are the largest, nearly ear-shaped, or sometimes semi-tubular. They are distinguished from the bullæana by the opercular scutcheon which covers the branchial cavity, which, as well as the tentacula, is wanting in that family. This scutcheon contains a horny or cretaceous piece, the element of a shell, which has never the singular convolution of that of the bulla, or bullæa. The laplysiana breathe only water.

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* *Belonging to wood.*

1. Laplysia[*].

Body creeping, oblong, convex, bordered on each side by a wide mantle, which, when at rest, covers the back. Head supported by a neck; four tentacula, two superior, auriform[†], two near the mouth. Eyes sessile, in front of the auriform tentacula. Scutcheon dorsal, semi-circular, subcartilaginous, fixed by one side, and covering the branchial cavity. Anus behind the branchiæ.

The mouth of the laplysia is cleft longitudinally, almost like that of a hare, and the cavity of the stomach is lined with little solid semi-cartilaginous, pyramidal bodies, which defend the internal surface of that organ. The laplysia swims with ease, but crawls slowly.

Type. *Laplysia depilans*[‡]. (Idem. *Linn.*)

Body livid, blackish brown; posteriorly obtuse. Shell, a dorsal, subcartilaginous scutcheon. *Mediterranean.* Pl. VII. Fig. 124. 3 Species.

2. Dolabella[§].

Body crawling, oblong, contracted anteriorly, posteriorly dilated, and obliquely truncated by an inclined orbicular plane; borders of the mantle folded closely on the back. Four semi-tubular tentacula disposed in pairs. Operculum of the branchiæ containing a shell, covered by the mantle, and situated near the posterior part of the back. Anus dorsal near the branchiæ, in the middle of the orbicular facet.

Shell oblong, slightly arched, securiform; contracted, thick, callous, and nearly spiral on one side; wider, flatter, and thinner on the other.

Type. *Dolabella Rumphii*[‖].

Shell thick at the base, callous, subspiral; dilated at the upper part, thin, wedge-shaped. *Indian Ocean.* Pl. VII. Fig. 125. 2 Species.

[*] *Απλυσια, a sponge which cannot be cleaned.*

[†] Their form is similar to that of a hare's ear.

[‡] *Causing the hair to fall off*—an effect attributed to a fetid whitish mucus, which exudes when the animal is touched. It excites nausea, and even vomiting.

which exudes when the animal is touched. It excites nausea, and even vomiting.

[§] *A little axe, or hatchet.*

[‖] Of *Rumphius.*

7th Family.

LIMACIANA. (5 Genera.)

Branchiæ resembling a vascular net-work, extended over the side of an appropriate cavity, the aperture of which the animal contracts or dilates at pleasure. They breathe only free air.

This family is very remarkable, the individuals which compose it being the only gasteropoda that breathe nothing but free air, although their respiratory organ is truly branchial. Hence, Lamarck proposes to call them *pneumobranchial.* They are quite, or very nearly, naked. Their body is long, creeping on an attached ventral disk, and bordered at the sides by an, often very short, mantle. They live in the neighbourhood of water, or in cool, damp places.

1. ONCHIDIUM.

This genus has no shell.

2. PARMACELLA.

Body creeping, oblong, inflated near the middle, where the scutellum is situated, terminated by a tail, compressed at the sides, acute above. Scutcheon oval, fleshy, adhering to the posterior part, anteriorly free, containing a shell, and notched in the middle of its right border. Orifice for respiration, and anus under the fissure in the scutcheon. Four tentacula; the two posterior the largest. Orifice for generation between the two tentacula, on the right side.

The Parmacella is a land animal, nearly allied to the limax, but distinguished from it by the anterior half of its scutcheon not being attached to the body. In each genus the scutcheon envelopes a solid, cretaceous body, which, in the parmacella, has the true form of a shell, whilst, in the limax, it is the mere element of one.

Type. *Parmacella caliculata* *.

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* *Cup-shaped.*—" Shell small, like a very flat bowl of a spoon, with a very short papilliform spire, contracted at its base, the aperture of its spire very small, but the outer lip very much spread out, and rather irregular"— " covered on the outside with a light-brown, thin, horny epidermis." The specific name and description of the Parmacella, which we have given as our type, is taken from Mr. G. B. Sowerby. (*Genera of Recent and Fossil Shells.*) The shell, from which our figure is taken, was furnished us by the kindness of Mr. Henry Stutchbury. Lamarck gives but one species, *P. Oli-*

3. Limax *.

Body oblong, naked, creeping, convex above, furnished anteriorly with a coriaceous, subrugose shield; below, with a flat longitudinal disk. Four retractile tentacula; the two posterior largest, with eyes at the summit. Branchial cavity under the shield, at the anterior part of the body. Orifice for respiration, and anus, at the right side of the shield; that for generation in front, between the two tentacula on the right.

The limax is a land animal; its skin is more or less rugose and sulcated externally. It has much analogy with the helix and bulimus, from which it differs principally in having no true shell, and by its shield, and other essential peculiarities. It creeps slowly, using its tentacula to feel the bodies that lie in its way, and which it projects and retracts, in the same manner that one turns the finger of a glove inside out. The animal is hermaphrodite and herbivorous, and frequents shady, damp places.

Type. *Limax rufus* †. (Idem. *Linn.*)

Body longitudinally sulcated, reddish above, white underneath. *Infests gardens,* &c. Pl. VII. Fig. 127. 4 Species.

4. TESTACELLA.

Body creeping, elongated, limaciform, furnished with a shell at the posterior extremity. Four tentacula, the two largest with eyes at the summit. Orifice for respiration, and anus at the posterior extremity; that for generation under the largest tentaculum, on the right side.

Shell very small, external, subauriform; apex slightly spiral; aperture very large, oval, obliquely effuse; left margin involute.

The testacella is chiefly distinguished from the limax by the very small shell which covers the posterior extremity of the animal. It is, however, less allied to the limax than is the parmacella, with respect to the branchial cavity, and the posi-

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vieri, and no specific description of the shell. Mr. Sowerby has adopted the name *calyculata*, "on account of a little testaceous ridge, which surrounds the aperture of the spire, formin a little cup." Pl. VII. Fig. 126.

* *A slug.* † *Reddish.*

tion of the anus. The testacella is seldom met with alive, living almost constantly buried in the ground, where it preys on earth-worms.

One Species. *Testacella haliotidea* *.

No farther description. *South of France.* Pl. VII. Fig. 128.

5. VITRINA †.

Body creeping, elongate, limaciform, greatest part straight; hinder part separate from the foot, spiral, and enveloped in a shell. Several posterior appendages of the mantle spread over the shell, apparently for the purpose of cleaning it, and partly cover it. Four tentacula, the two anterior very short. Orifice for respiration, and anus, very far back, on the right side.

Shell small, very thin, depressed, terminated above by a short spire; last whorl very large. Aperture large, rounded-oval; left margin arched, slightly involute.

The Vitrina is small, and frequents cool, shady places.

One Species. *Vitrina pellucida* ‡.

No further description. *France.* Pl. VII. Fig. 129.

Third Order.

TRACHELIPODA.

Body spiral at the posterior part, which is separated from the foot, and always enveloped in the shell. Foot free, flattened, attached to the inferior base of the neck, or the anterior part of the body, and serves for creeping. Shell spirivalve, ensheathing.

The trachelipoda differ from the gasteropoda, by the posterior portion of the body being spirally convolute, and by the greater part of the foot being free, and only attached to the inferior base of the neck, or fore-part of the body. The spiral portion of the body never projects beyond the shell, its natural conformation not allowing it to extend itself in a straight line.

All the trachelipoda are conchiferous; their shell, generally external, is always more or less spiral.

The genera and species of this order are much more numerous and diversified than those of the gasteropoda. The greater part of them inhabit the sea, some live in fresh water, and others on land. The shell of the latter is not at all, or only very slightly, pearly, and generally has no other external projections than the striæ of growth.

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* *Like a haliotis.*

† *From vitrum, glass.*

‡ *Transparent.*

Lamarck divides the trachelipoda into two sections.

SECTION I.

TRACHELIPODA, without any Siphon. (Phytiphaga *.)

No projecting siphon; animal generally breathes by a hole. The greater part feed on vegetables, and are furnished with jaws.

Aperture of the shell entire; base without any ascending dorsal notch, or canal.

This section contains ten families.

1st Family.

COLIMACEA. (11 Genera.)

Breathe air; some furnished with an operculum, others not; tentacula cylindrical.

Shell spirivalve; no external projecting parts, except the striæ of growth; right margin of the aperture often curved outwards.

All the colimacea are land animals; the first nine genera have four tentacula, the two last, only two.

1. HELIX †.

Shell orbicular, convex, or conoidal, sometimes globular; spire but little elevated. Aperture entire, transverse, very oblique, contiguous to the axis of the shell; margins disunited by the projection of the penultimate whorl.

The Helix is distinguished from the pupa, by the general form of the shell, which is never cylindrical, and by the borders of the aperture being disunited; from the bulimus, by the aperture being rather transverse than longitudinal, and its plane very oblique, and almost perpendicular to the axis of the spire; and from the planorbis, by the left margin of the aperture

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* *Herbivorous.*

† *A spiral line.*

being contiguous to the axis of the shell, whereas, in that genus, it is very remote from it. Lastly, the right margin, in the adult helix, is reflected outwards, which it never is in aquatic shells. The Helix is readily known by the projection of the penultimate whorl into the aperture, whence Linnæus described it, "*apert*ur*â intus lunatâ ; segmento circuli dempto.*"

The animal has great resemblance to the limax.

The species of this genus are almost innumerable—Lamarck describes only those in his own collection.

Type. *Helix gigantea* [*]. (Helix cornu militaire. *Linn.*)

Shell orbicular-convex, imperforate, solid, white; epidermis red-brown; whorls transversely striated, aperture wide; lip white within; margin reflected. *Germany.* Pl. VII. Fig. 130. 107 species.

2. CAROCOLLA.

Shell orbicular, more or less convex, or conoidal, on the upper part, with a sharp, angular periphery. Aperture transverse, contiguous to the axis of the shell; right lip subangular, often toothed on the lower part.

The sharp edge of the last whorl, their being always orbicular, and sometimes considerably depressed, are the principal characteristics of the shells of this genus.

Type. *Carocolla acutissima* [†].

Shell discoidal, convex on both sides, imperforate; periphery compressed and very acute; tawny; striæ small, oblique, very minutely granular; margin reflected, bidentate at the lower part. *Jamaica.* Pl. VII. Fig. 131.—18 Species.

3. ANOSTOMA [‡].

Shell orbicular, spire convex and obtuse. Aperture rounded, toothed within, ringent, turned upwards; margin of the right lip reflected.

The singular position of the aperture, directed upwards, towards the spire of the shell, is the characteristic of this genus, and peculiar to it.

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[*] *Gigantic.* Lamarck's second species—his type is *H. vesicalis.*

[†] *Very acute.*

[‡] From *ανω*, *upwards*, and *στομα*, *a mouth.*

Type. *Anostoma depressum**. (Helix ringens. *Linn.*)

Shell suborbicular, convex on both sides, somewhat depressed, obtusely carinate, imperforate, smooth, whitish; a circular red line on the upper part; aperture with five teeth; lip very much reflected. *India.* Pl. VII. Fig. 132.—2 Species.

4. HELICINA.

Shell subglobular, no umbilicus. Aperture entire, semi-oval. Columella callous, transverse, rather flattened, with a sharp edge forming an angle at the lower base of the right lip. Operculum horny.

The Helicinæ resemble small neritæ, but the latter are sea shells. They are distinguished from the helices by their transverse columella, which is callous, depressed, and thin at the lower part. They are land shells, and inhabit warm climates.

Type. *Helicina neritella.*

Shell ventricose, globular-conoidal; smooth, white; margin reflected. *Antilles.* Pl. VII. Fig. 133.—4 Species.

5. PUPA †.

Shell cylindrical, generally thick. Aperture irregular, semi-oval, rounded, and subangular at the lower part; margins nearly equal, reflected outwards, and disunited above by an interposed columellar lamina.

Type. *Pupa mumia* ‡.

Shell cylindrical, attenuated, obtuse, thick, white; furrows of the whorls longitudinal, oblique; aperture red-brown, biplicate; margin reflected. *Antilles.* Pl. VII. Fig. 134.—27 Species.

6. CLAUSILIA §.

Shell generally fusiform, slender, summit rather obtuse. Aperture irregular, rounded-oval; margins united throughout, free, reflected outwards.

The essential character of the clausilia, is that the two borders of the aperture are completely united, free in their contour, and reflected outwards.

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* *Depressed.* † *A puppet.* ‡ *A mummy.*

§ From *claudo*, to *shut*, because the aperture of the shell is closed by a little apparatus, consisting of two small valves, situated in the penultimate whorl, and not visible externally.

Type. *Clausilia torticollis* *.

Shell reverse, cylindrical, truncated; striæ straight, ferruginous-red; neck narrow, angular, and arched; aperture without teeth. *Isle of Candy.* Pl. VII. Fig. 135.—12 Species.

7. BULIMUS †.

Shell oval, oblong, or turrited; aperture entire, longitudinal; margins very unequal, disunited at the upper part. Columella straight, smooth; no truncation or notch at the base.

The last whorl of the spire of the bulimus is larger than the penultimate; the shell is never orbicular, like the helix; and it differs from the pupa, by the great inequality of the two margins of the aperture, the right of which is sometimes considerably thickened.

Type. *Bulimus hæmastomus* ‡. (Helix oblonga. *Gmel.*)

Shell ovate-oblong, ventricose, subperforate, longitudinally striated, whitish-yellow; lip and columella purple. *Guyana.* Pl. VII. Fig. 136.—34 Species.

8. ACHATINA.

Shell oval or oblong; aperture entire, longitudinal; right margin sharp, never reflected. Columella smooth, truncated at the base.

This genus is well distinguished from the preceding, by the right margin never being reflected, and by wanting that on the left; the columella being always naked, very smooth, and truncated at the base.

Lamarck subdivides the genus into, 1. Those shells which have the last whorl ventricose, and not depressed,—12 Species; and, 2. Those with it depressed, and attenuated towards the base,—7 Species.

Type. *Achatina perdix* §. (Bulla achatina. *Linn.*)

Shell very large, ovate-oblong, ventricose, decussated, white, apex rosy; light red, wavy, longitudinal streaks; columella violet-purple; interior of the lip white. *Antilles.* Pl. VII. Fig. 137.—In all, 19 Species.

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* *Wry-necked.*

† βυλιμος, *insatiable hunger.* What title this genus has to so strange a name, we know not.

‡ *Bloody-mouth.* Lamarck's second species. His type is *B. ovatus.*

§ *A partridge.*

9. SUCCINEA *.

Shell oval, or ovate-conical. Aperture large, entire, longitudinal; right margin sharp, not reflected; united at the lower part to a smooth, attenuated, acute columella. No operculum.

The Succineæ live habitually on land, in the neighbourhood of water, which they occasionally frequent. They are distinguished from the bulimi, by the right margin never being reflected, and from the lymnææ, by their columella being free from folds.

Type. *Succinea amphibia* †. (Helix putris. *Linn.*)

Shell ovate-oblong, very thin, transparent, yellowish; spire short; aperture dilated, at the lower part, subvertical. *France.* Pl. VII. Fig. 138.—3 Species.

10. Auricula ‡.

Shell suboval, or oval oblong. Aperture longitudinal, very entire at the base, contracted at the upper part, where the margins are disunited. One or more folds on the columella. Lip sometimes reflected outwards, sometimes simple and sharp.

Land-shells, and distinguished from bulimus, by the folds on the columella. The genus is subdivided into (1,) those with the right margin reflected outwards—10 species; and (2) those with the margin simple and sharp—4 species.

Type. *Auricula Midæ* §. (Voluta auris Midæ. *Linn.*)

Shell ovate-oblong, very thick, decussately striated, granular above, white; chestnut brown epidermis; spire short, conoidal; middle of the aperture contracted; columella biplicate.

East Indies. Pl. VII. Fig. 139.—14 Species.

11. Cyclostoma ||.

Shell of variable form; sometimes subdiscoidal, sometimes conical, or turrited, or subcylindrical. Whorls of the spire cylindrical. Aperture round, regular; margins circularly united, open, or reflected by age. Operculum horny.

Land-shells, never pearly, generally thin, and without squamæ or tubercles on the outside, distinguished from the paludinæ

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* *Amber-coloured.*

† *Amphibious.*

‡ *A little ear.*

§ *Midas's.*

|| κυκλος, *a circle, and* στομα, *a mouth.*

by the outward reflection of the margin of the adult shell, whilst in that genus it is always sharp, and not reflected; from the pupa, by the regularity of the aperture, which is never angular.

Type. *Cyclostoma volvulus* *.

Shell trochiform, deeply umbilicate; transversely striated; variegated with brownish white and red; spire acuminated; aperture white, or brownish; margin reflected. Pl. VII. Fig. 140. 28 Species, the two last doubtful.

2d Family.

LYMNÆANA. (3 Genera.)

Amphibious trachelipoda, generally provided with an operculum, and two flattened tentacula without eyes at their summit. They live in fresh water, and come to the surface to breathe air.

Shell spirivalve, generally smooth externally; right margin of the aperture always acute and not reflected.

1. Planorbis †.

Shell discoidal, spire flattened, scarcely projecting; all the whorls visible on both sides. Aperture oblong, lunate, very distant from the axis of the shell; margin not reflected. No operculum.

Fresh water shells, generally thin, brittle, diaphanous; the whorls of some are subcylindrical, of others carinate or angular. Aperture sublongitudinal, with an internal projection formed by the penultimate whorl.

Type. *Planorbis corneus* ‡. (Helix cornea. *Linn.)*

Shell opaque, flat depressed above, broadly umblicate below; horn or chestnut brown; whorls transversely striated.

France. Pl. VII. Fig. 141. 12 Species.

2. Physa §.

Shell convolute, oval or oblong, spire projecting. Aperture longitudinal, contracted above. Columella twisted. Right margin very thin, acute, partly projecting beyond the plane of the aperture. No operculum.

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* *A twisting.*

† *From planus, flat, and orbis, an orb.*

‡ *Horny.* Lamarck's second species. His type, *P. cornu arietis*, Mr. Sowerby considers as an *Ampullaria.*

§ Mr. Sowerby is of opinion, that there is not sufficient ground for forming distinct genera, of this and the following shell. He has therefore struck out physa, and placed it with the genus lymnæa. (Genera of recent and fossil shells. No. 8.)

The physæ are fresh water shells, thin, brittle and generally reverse. They are distinguished from the bullæ by their projecting spire, and from the lymnæa, which they otherwise much resemble, by the aperture not being dilated, the right margin projecting a little above its plane.

Type. *Physa fontinalis* *. (Bulla fontinalis. *Linn.*)

Shell reverse, oval, diaphanous, smooth, horn-brown, (luteo-corneâ;) spire very short, sub-acute. Pl. VII. Fig. 142.—4 Species.

3. Lymnæa.

Shell oblong, sometimes turrited, often rather ventricose below, generally thin; spire projecting. Aperture entire longitudinal. Right margin acute, its lower part, turning to the left and ascending, passes over the columella towards the aperture, forming a very oblique fold. No operculum.

The very oblique fold on the columella, distinguishes the lymnæa from the bulimus, and the regular uninterrupted plane of the aperture, from the physa.

Type. *Lymnæa stagnalis* †. (Helix stagnalis. *Linn.*)

Shell acute-ovate, ventricose, thin, transparent, longitudinally substriated; reddish grey; last whorl subangular above; spire conico-subulate; aperture large; lip broad.

France. Pl. VII. Fig. 143. 12 Species.

3rd Family.

MELANIANA. (3 Genera.)

Operculated, fluviatile trachelipoda; breathe only water. Two tentacula. Operculum horny.

Borders of the aperture of the shell disunited; right margin always acute.

Most of the shells of this family are exotic, and are covered with a brownish green or blackish epidermis.

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[*] *Of the springs.* Lamarck's second species; his type is *P. castanea.*

[†] *Of stagnant waters.* The first species, *L. columnaris*, Lamarck has removed to the genus *Achatina*—See erratum. Vol. vii. p. 678.

1. Melania [*].

Shell turrited. Aperture entire, oval or oblong, effuse at the base. Columella smooth, incurved. Operculum horny.

Type. *Melania truncata* [†].

Shell turrited, apex truncated, solid, blackish brown; ribs longitudinal, the superior most projecting, decussated by numerous transverse striæ; whorls plano-convex..

Guiana. Pl. VII. Fig. 144. 16 Species.

2. Melanopsis [‡].

Shell turrited, aperture entire, oblong-oval. Columella callous above, truncated at the base, separated from the right lip by a sinus. An operculum.

The callus on the upper part of the columella distinguishes the Melanopsis from the Melania, as well as its being truncated at its base like the achatina, which is never the case with the Melania.

Type. *Melanopsis lævigata* [§].

Shell ovate-conical, smooth, chestnut colour; six whorls, rather flattened, convex at the spire; the last whorl towards the spire the longest.

Archipelago. Pl. VII. Fig. 145. 2 species.

3. Pirena [‖].

Shell turrited; aperture longitudinal; right lip acute, with a sinus at its base, and another at the summit. Base of the columella curved towards the right margin. Operculum horny.

Principally distinguished from Melanopsis by having no callus on the columella, and from that genus and melania by a sinus both at the base and summit of the right lip.

Type. *Pirena terebralis* [¶]. (Strombus ater, *Linn.*)

Shell subulate-turrited, smooth, black; whorls flattened; aperture white.

India. Pl. VII. Fig. 146. 4 species.

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[*] *From μελας, black.*

[†] *Truncated*—2nd Species. Lamarck's type is *M. asperata.*

[‡] From μελας, *black*, and οψις, *a face.*

[§] *Smooth*—2nd Species. Lamarck's type is *M. costata.*

[‖] From πειρα, *the point of a sword.*

[¶] From *terebro, to pierce.*

4th Family.

PERISTOMIANA. (3 genera.)

Operculated, fluviatile trachelipoda; breathe only water. Shell operculated, conoidal, or subdiscoidal; borders of the aperture united.

The shells of this family all belong to fresh water, and have a thin greenish or brown epidermis. They are distinguished from the three preceding genera by the margin of the aperture being united.

1. Valvata[*].

Shell discoidal or conoidal; whorls cylindrical; spiral cavity complete, or not deranged by the penultimate whorl; aperture rotundate; margins united, acute: operculum orbicular.

Type. *Valvata piscinalis*[†].

Shell globose-conoidal, subtrochiform, perforate, whitish; about five whorls; apex of the spire obtuse.

France. Pl. VII. Fig. 147. 4 species are known, but Lamarck only describes the above.

2. Paludina[‡].

Shell conoidal, whorls rounded or convex, modifying the spiral cavity; aperture rounded oval, longitudinal, angular at the summit; the two margins united, acute, never curved outwards; operculum orbicular, horny.

The paludinæ generally live in fresh water, though some inhabit brackish, and even salt, water. They are distinguished from the valvatæ by the somewhat elongated and angular form of the aperture.

Type. *Paludina vivipara*[§]. (Helix vivipara, *Linn.*)

Shell ventricose-conoidal, thin, diaphanous, very delicately striated longitudinally, brownish green; obsolete, brown-red, transverse bands; five whorls, rotundate, turgid; sutures very marked.

France. Pl. VII. Fig. 148. 7 species.

---

[*] *Valva, a folding door,* or *valve.*

[†] *Of the pools.*

[‡] From *palus, a marsh.*

[§] *Viviporous*

3. Ampullaria *.

Shell globular, ventricose, umbilicate at the base; no callus on the left lip; aperture entire, longitudinal; margins united; right margin not reflected; an operculum.

The last whorl is, at least, four times as large as the penultimate. The columellar lip projects, and is reflected over the umbilicus, forming a half funnel, but no callus. The shells of this genus are generally large.

Type. *Ampullaria Guyanensis* †.

Shell ventricose-globular, solid, longitudinally, and unequally striated; epidermis brown; six whorls; last whorl the largest; aperture orange-coloured.

Rivers of Guiana. Pl. VII. Fig. 149. 11 species.

5th Family.

NERITACEA. (4 genera.)

Operculated trachelipoda; some inhabit fresh water, others are marine.

Shell fresh-water or marine, semi-globular or flattened oval; no columella; left margin of the aperture acute, transverse, and resembling a half partition, with which the operculum articulates.

1. Navicella ‡.

Shell elliptical or oblong, convex above; summit straight, depressed to the margin; under side concave. Left margin flattened, acute, narrow, toothless, transverse §; operculum solid, flat, with an acute lateral tooth.

Exotic, fresh-water shells; distinguished from nerita and neritina by the summit not being spirally convolute. The transverse, left lip, never covers half the cavity.

Type. *Navicella tessellata* ||.

Shell oblong elliptical, thin, diaphanous, tessellated with yellowish and brown oblong square spots; vertex maginal, not projecting.

Rivers of India. Pl. VIII. Fig. 150. 3 species.

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* *Ampulla, a wide-bellied bottle.* † *Of Guiana.* ‡ *Pro navicula, a little boat.*

§ The transverse position of the flattened left lip gives the shell, when held with the concave side upwards, the appearance of a little boat with a half-deck. || *Tessellated*—3rd Species. Lamarck's type is *N. elliptica.*

2. Neritina[*].

Shell thin, semi-globular or oval, flattened on the lower part; no umbilicus. Aperture semi-circular; left lip flattened, acute; no teeth, nor crenations on the internal face of the right margin. Operculum furnished with a projecting apophysis, or lateral tooth, on one side.

Fresh-water shells, generally thin, and smooth externally.

Type. *Neritina pulligera*[†]. (Nerita pulligera. *Linn.*)

Shell ovate, delicately striated, blackish brown, dotted with small round young shells, which adhere to it; lip dilated, thin, white internally; margin acute; lower border yellowish; lip crenate.

India. Pl. VIII. Fig. 151. 21 species.

3. Nerita[‡].

Shell solid, semi-globular, flattened on the lower part; no umbilicus. Aperture entire, semi-circular; left lip flattened, septiform, acute, often crenate; internal face of the right lip crenate. Operculum furnished with an apophysis.

All sea-shells, solid, rather thick, and agreeably varied in colour. The spire is but little elevated above the last whorl. The operculum is crescent-shaped, horny, or calcareous, and exactly closes the aperture. When the animal comes out of the shell, the operculum falls back on the flat part of the columella, like a shutter. The nerita differs from neritina by the internal face of the right margin being crenate, and from natica by having no umbilicus.

Type. *Nerita exuvia*[§]. (Idem, *Linn.*)

Shell thick, white, spotted with black; ribs transverse, those on the back acute, rough-squamose, decussated by longitudinal striæ; interior of the lip crenate; upper part of the margin verrucose, and toothed.

Indian Ocean. Pl. VIII. Fig. 152. 17 species.

4. Natica.

Shell sub-globular, umbilicated; aperture entire, semi-circular; left lip oblique, not crenate, callous; form of the umbilicus modified by the callus, and sometimes covered by it; right lip acute, always smooth internally; operculum generally solid, calcareous.

---

[*] Dim. of *Nerita.*

[†] *Bearing its young.*

From νηρίτης, *the Greek name for a kind of sea shell,—from νέω, to swim, because it swims on the sea.*

[§] *Exuviæ, spoils.*

Sea-shells, distinct from nerita, by the umbilicus, and by the columellar margin not being crenate, but smooth, and callous, and by the smoothness of the interior of the right lip.

Type. *Nerita glaucina*[*]. (Idem, *Linn.*)

Shell suborbicular, inflated, thick, smooth, whitish yellow, and cœrulescent; spire short, oblique; callus subdivided, partly covering the umbilicus, red.

Bay of Campeachy. Pl. VIII. Fig. 153.—31 species.

6th Family.

IANTHINEA[†]. (1 Genus.)

Shell inflated, conoidal, thin, transparent. Aperture triangular. Columella straight, projecting beyond the base of the right lip; a sinus in the middle of the latter. No operculum.

Sea shells, always found at the surface of the water, of a violet colour throughout, very thin, transparent, and brittle.

Type. *Ianthina communis*[‡]. (Helix Ianthina. *Linn.*)

Shell ventricose-conoidal, longitudinally sub-rugose, transversely delicately striated, violet; last whorl large, angular; apex of the spire rather obtuse. *Mediterranean.* Pl. VIII. Fig. 154.—2 Species.

7th Family.

MACROSTOMIANA[§]. (4 Genera.)

Shell auriform, aperture extremely dilated, margins disunited. No columella, nor operculum.

1. SIGARETUS.

Shell sub-auriform, nearly orbicular; left margin short, spiral. Aperture entire, very dilated, longitudinal; margins disunited.

The shell of the Sigaretus is concealed under the mantle of the animal.

---

[*] *Bluish, or sea-green colour.*

[†] From *Ianthum*, a *violet.*

[‡] *Common.*

[§] From *μακρος*, *large*, and *στομα*, a *mouth.*

Type. *Sigaretus haliotoideus*[*]. (Helix haliotoidea. *Linn.*)

Shell auriform, back depressed, convex; undulately striated transversely, whitish; spire very obtuse; aperture very dilate; umbilicus covered. *Atlantic Ocean.* Pl. VIII. Fig. 155.—4 Species.

2. STOMATELLA [†].

Shell orbicular or oblong, auriform, imperforate. Aperture entire, large, longitudinal; right margin effuse, dilated, open.

Distinguished from stomatia, by not having the transverse rib of that shell, nor the right lip so much elevated; and from the haliotis, by wanting the foramina, or row of perforations, which mark that genus. They are all sea shells, pearly externally.

Type. *Stomatella sulcifera*[‡].

Shell sub-orbicular, convex, thin, transversely sulcated, very delicately striated longitudinally, reddish-grey; furrows rather rough; spire slightly projecting. *New Holland.* Pl. VIII. Fig. 156.—5 Species.

3. STOMATIA [§].

Shell auriform, imperforate; spire prominent. Aperture entire, large, longitudinal; right and columella lip equally elevated. Dorsal rib transverse, tuberculated.

Distinguished from haliotis by the dorsal rib being imperforate. Sea shells, sometimes very pearly.

Type. *Stomatia phymotis*[‖]. (Haliotis imperforata. *Chemn.*)

Shell resembling a haliotis, ovate-oblong, back convex, striated, nodular, silvery; spire minute, contorted; lip thin, acute. *Indian Ocean.* Pl. VIII. Fig. 157.—2 Species.

4. HALIOTIS [¶].

Shell auriform, usually flattened; spire very short, sometimes depressed, sublateral. Aperture very large, longitudinal, and, in the perfect shell, entire. Disc perforated with holes, disposed in a line parallel to, and near the left lip; the last hole incomplete, forming only a notch. No operculum.

---

[*] *Like a haliotis.*

[†] *Dim. from στομα, a mouth.*

[‡] *Furrowed.* 3d Species.—Lamarck's type is *S. imbricata.*

[§] *From the same Greek word as the last genus.*

[‖] *From φυμα, a mushroom, or the knotty excrescence of a tree, and ους, an ear.*

[¶] *From ἁλς, the sea,* and *ους, an ear.*

Type. *Haliotis Iris* *. (Idem. *Gmel.*)

Shell rounded-oblong, very large, thin, rugose-plicate, prettily varied with green, red, and blue; spire sub-prominent, obtuse; left lip elevated. *New Zealand.* Pl. VIII. Fig. 158.—15 Species.

8th Family.

PLICACEA †. (2 Genera.)

Aperture of the shell not dilated; columella plaited.

All sea shells, distinct from the Auriculæ, which are land shells, by their general form and projecting spire; and from the Volutæ, Mitræ, *&c.*, by having no notch at the base of the aperture.

1. TORNATELLA ‡.

Shell convolute, ovate-cylindrical, generally striated transversely; no epidermis. Aperture oblong, entire; right lip acute; one or more plaits, usually thick and obtuse, on the columella. Spire prominent.

Type. *Tornatella flammea* §. (Voluta flammea. *Linn.*)

Shell oval, ventricose, transversely striated, white, with red, wavy, longitudinal markings; spire conoidal, columella with one fold. Pl. VIII. Fig. 159.—6 Species.

2. PYRAMIDELLA ‖.

Shell turrited, no epidermis. Aperture entire, semi-oval; outer lip acute. Columella straight, projecting at the base, subperforate; three transverse folds on the columella.

Type. *Pyrmidella dolabrata* ¶. (Trochus dolabratus. *Linn.*)

Shell conico-turrited, perforate, smooth, white, with surrounding yellowish lines; columella recurved; interior of the lip toothed, and sulcated. *South America.* Pl. VIII. Fig. 160. 5 Species.

---

* *A rainbow.* 2d species.—Lamarck's type is *H. midæ.*

† *From plico, to fold.*

‡ *From torno, to turn in a lathe.*

§ *Yellow, or flame colour.*

‖ *From pyramis, a pyramid.*

¶ *Cut with an axe.* 2d Species—Lamarck's type is *P. terebellum.*

9th Family.

SCALARIANA. (3 Genera.)

No plaits on the columella; margins of the aperture circularly united. All sea shells.

The shells of the Scalariana have a tendency to form a loose spire, so that the whorls are often disunited, and do not rest one on another.

1. VERMETUS *.

Shell thin, tubular, loose spiral; spire adhering by the apex. Aperture orbicular, margins united. Operculum cartilaginous.

This shell has great resemblance to a serpula; its animal, however, is not one of the *annulata*, but a true *molluscum*, and properly placed with the trachelipoda. (See Adanson's *Senegal*, Pl. xi. fig. 1. Vermetus.) The vermeti are commonly found in groups, twisted together.

One Species. *Vermetus lumbricalis* †.

Shell attached by the apex of the spire, extended anteriorly into an ascending tube, thin, transparent, reddish yellow. *Senegal.* Pl. VIII. Fig. 161.

2. SCALARIA ‡.

Shell sub-turrited, spire more or less elongated, last whorl rather larger than the penultimate; ribs longitudinal, elevated, interrupted, sub-acute. Aperture nearly round; margins circularly united, and terminated by a thin curved varix.

Type. *Scalaria pretiosa* §. (Turbo scalaris, *Linn.*)

Shell conical, umbilicated, loose, spiral, pale yellow; ribs white; whorls disunited, smooth, the last ventricose. *Indian Seas.* Pl. VIII. Fig. 162.—7 recent species, and 3 fossil.

3. DELPHINULA ||.

Shell subdiscoidal, or conical, umbilicated, solid, internally pearly, whorls of the spire rough, or angular. Aperture entire, round, sometimes triangular; margins united, generally fringed or varicose.

Distinguished from turbo, by the united margins.

---

* *From vermis, a worm.*

† *From lumbricus, an earth-worm.*

‡ *From scala, a flight of steps.*

§ *Costly, precious.*

|| Dim. from *delphinus*, a *dolphin*.

Type. *Delphinula laciniata*[*]. (Turbo delphinus. *Linn.*)

Shell subdiscoidal, thick, transversely rudely sulcated; furnished with very large, curved, ramose, jagged appendages; variegated with red and brown: spire obtuse. *Indian Ocean.* Pl. VIII. Fig. 163.—3 recent species, and 7 fossil.

10th Family.

TURBINACEA[†]. (8 Genera.)

Shell turrited or conoidal; aperture round or oblong, not dilated; margins disunited.

All sea-shells, and appear to be operculated. When placed on their base, the axis is always more or less inclined, never vertical.

1. Solarium[‡].

Shell orbicular, depressed conical; umbilicus open, always crenate or toothed on the internal margins of the whorls. Aperture subquadrangular; no columella.

The crenate umbilicus of the solarium sufficiently distinguishes it from the trochus and planorbis.

Type. *Solarium perspectivum*[§]. (Trochus perspectivus. *Linn.*)

Shell orbicular, conoidal, longitudinally striated, whitish yellow; bands articulated with white and brown, or chestnut colour near the sutures; crenations of the umbilicus very small. *Indian Ocean.* Pl. VIII. Fig. 164. 7 recent species, and 8 fossil.

2. Rotella[‖].

Shell orbicular, shining, no epidermis; spire very short, subconoidal; lower face convex, callous. Aperture semicircular.

Distinguished from trochus by the lower surface being remarkably callous, and from the helicina by the callous not being confined to the columellar lip, but extending over a large portion of the lower side of the shell.

Type. *Rotella lineolata*[¶]. (Trochus vestiarius. *Linn.*)

---

[*] *Jagged.*

[†] *From turbinatus, fashioned like a top?*

[‡] *A sun dial.*

[§] *Perspective.*

[‖] *A very small wheel.*

[¶] *Marked with little lines.*

Shell orbicular, convex, conoidal, very smooth, pale flesh-colour; numerous undulated, brown, longitudinal lines; whorls contiguous; lower face white. *Mediterranean*. Pl. VIII. Fig. 165. 5 Species.

3. Trochus[*].

Shell conical, spire elevated, sometimes rather depressed; periphery more or less angular, often thin and acute. Aperture depressed transversely; margins disunited at the upper part. Columella arched, more or less prominent at the base. An operculum.

Many trochi have a brilliant pearly surface, and several have longitudinal ribs, which, we believe, are never found in the turbo.

Type. *Trochus imperialis*[†]. (Idem. *Gmel.*)

Shell orbicular-conoidal, apex obtuse, brown inclining to violet above, white below; transverse furrows, imbricate-squamose; whorls convex, turgid, radiated with a squamose margin; squamæ complicate; umbilicus funnel-shaped.—*South Seas*. Pl. VIII. Fig. 166. 69 Species.

4. Monodonta[‡].

Shell oval or conoidal. Aperture entire, round; margins disunited at the upper part. Columella arched, truncated at the base. Operculum orbicular, thin, horny.

Distinguished from trochus chiefly by the more circular form of the mouth; from turbo by the columella being truncated at the base, and forming a characteristic dentiform projection in the aperture.

Type. *Monodonta pagodus*[§]. (Turbo pagodus. *Linn.*)

Shell obliquely conical, imperforate, tubercular, ribbed longitudinally, transversely furrowed, brownish grey; ribs terminating in long, compressed tubercles beyond the margin of the spires; lower face white, with concentric furrows, pimpled. *Indian Ocean*. Pl. VIII. Fig. 167. 25 Species.

5. Turbo[‖].

Shell conoidal, or subturrited; periphery never compressed;

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[*] *A child's top.*

[†] *Imperial.*

[‡] *From* μονος *one*, and οδυς *a tooth.*

[§] *Pagoda.*

[‖] *A wreath.*

whorls always round. Aperture entire, round, not disturbed by the penultimate whorl; lips disunited at the upper part, columella arched, flattened, not truncated at the base. An operculum.

The axis of the shell is generally more inclined than that of the trochus.

Type. *Turbo marmoratus**. (Idem. *Linn.*)

Shell subovate, very ventricose, imperforate, smooth, marbled, or subfasicated with green, white and brown; last whorl transversely nodular, in three directions; upper nodules largest; base of the lip expanded, caudate; mouth silvery. *Indian Ocean.* Pl. VIII. Fig. 168. 34 Species.

6. Planaxis†.

Shell oval-conical, solid. Aperture oval, sublongitudinal. Columella flattened, truncated at the base, separated from the right lip by a narrow sinus. Interior face of the right lip furrowed or striped, with a callus running under its summit.

The planaxis is distinguished from phasianella by the truncation of the columella; it is transversely furrowed externally, and generally of small size.

Type. *Planaxis sulcata*‡.

Shell ovate-conical, imperforate, transversely sulcated, white, spotted with black; spots subquadrate; margin of the lip crenate; internally striated. Antilles. Pl. VIII. Fig. 169. 2 Species.

7. Phasianella§.

Shell oval or conical, solid; the last whorl much larger than any of the others. Aperture entire, oval, longitudinal, inclined obliquely towards the base of the columella, round at the lower part, and contracted at the upper; lips disunited at the upper part; right margin acute, not reflected. Columella smooth, compressed, attenuated at the base. Operculum calcareous or horny.

Generally smooth, brilliant shells, without any epidermis, and ornamented with various lively colours.

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* *Marbled.* † *Flattened axis?* ‡ *Furrowed.*
§ *Dim. from Phasianus, a pheasant.*

Type. *Phasianella bulimoides*[*]. (Buccinum australe. *Gmel.*)

Shell oblong-conical, rather thin, smooth, palish yellow, transversely fasciated; fasciæ numerous, variously variegated and spotted; apex of the spire acute. *New Holland.* Pl. VIII. Fig. 170. 10 Species.

8. Turritella[†].

Shell turrited, not pearly. Aperture rounded, entire, margins disunited at the upper part, not reflected outwards; a sinus in the right lip. Operculum orbicular, horny.

Distinguished from turbo by the general form of the shell, and by the sinus on the right lip, a constant character. Most of the species are transversely carinated or striated, but none of them have vertical ribs, varices, or tubercles.

Formerly all the turrited shells were called screw shells. Thus turritella, scalaria, cerithium, *&c.*, were all confounded with the true screw shell, terebra.

Type. *Turritella duplicata*[‡]. (Turbo duplicatus. *Linn.*)

Shell turrited, thick, heavy, transversely sulcated and carinated, whitish yellow, apex reddish; whorls convex, carinated; the two middle carinæ most prominent. *Coast of Coromandel.* Pl. VIII. Fig. 171. 13 recent Species, and 2 fossil [§].

SECTION II.

TRACHELIPODA with a projecting siphon. (Zoophaga[‖].)

The animals of this section breathe only water, which is conveyed to the branchiæ by the projecting siphon. They are all carnivorous, marine, without jaws; and have a retractile proboscis. Two tentacula on the head.

Shell spirivalve, ensheathing, aperture canaliculated or notched, or merely inclined at the base.

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[*] *Resembling a bulimus.* [†] *Dim. from turris, a little tower.*

[‡] *Doubled, because it is bi-carinated.*

[§] Desmarets has described a new genus, established by Freminville, which we shall add in this place. It has been called *Rissoa;* we give a figure of one species.

Shell univalve, oblong or turrited, generally furnished with prominent longitudinal ribs, aperture entire, oval, oblique; no canal at the base; no tooth, nor plait; margins united, or nearly united; right margin inflated, not reflected. No umbilicus. *Gulf of Genoa.* Fig. 172. (Vide *Nouveau Bulletin des Sciences,* or *Nouveau Dictionnaire d'Histoire Naturelle.*)

[‖] *Carnivorus.*

This section contains five families; in the two first the canal at the base of the aperture is always manifest; in the third it disappears, and the two last have only a notch, and a small, low, inclined margin.

1st Family.

CANALIFERA. (11 Genera.)

Shell with a canal, variable in length, at the base of the aperture, the right margin of which does not alter by age. An operculum.

This family is separated into two divisions.

1st Division.

No constant varix on the right lip.

1. Cerithium[*].

Shell turrited. Aperture short, oblong, oblique, terminated at the base, by a short truncated or curved canal; never notched. A slight channel at the upper extremity of the right lip. Operculum small, orbicular, horny.

The spire of the shell constitutes at least two thirds of its whole length; the last whorl being but little larger than the preceding one, the shell has the form of an elongated pyramidal cone; surface generally striated or tubercular, and sometimes varicose.

A thorough knowledge of this numerous genus is very important to the modern geologist.

Type. *Cerithium palustre*[†]. (Strombus palustris. *Linn.*)

Shell turrited, thick, longitudinally plicate, transversely striated, brownish; whorls tri-striated, the last with very numerous sulciform striæ; lip sub-crenate.

East Indies. Pl. VIII. Fig. 173. 36 recent species, and 60 fossil.

2. Pleurotoma[‡].

Shell turrited, or fusiform, terminated at the lower part by a straight canal, more or less elongated. A fissure or sinus in the upper part of the right lip. Operculum oblong, horny.

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[*] From *Cerites, a gem of a waxen colour?*

[†] *Of the marshes;* Lamarck's 2d genus; his type is C. *giganteum.*

[‡] *From* ϖλευρα, *the side, and* τεμνω *to cut,* denoting the characteristic fissure on the right lip.

Type. *Pleurotoma Babylonica**. (Murex Babylonius. *Linn.*)

Shell fusiform, turrited, transversely carinated, and banded, white; bands spotted with black, spots quadrangular; whorls convex; base rather long.

Indian Ocean. Pl. VIII. Fig. 174. 25 recent species, and 30 fossil.

3. Turbinella †.

Shell turbinate, or subfusiform, channelled at the base; from three to five compressed, transverse folds on the columella.

Distinguished from voluta, by the canal at the base of the aperture; from murex by having no varices, and from fasciolaria by the direction of the folds on the columella.

Type. *Turbinella cornigera* ‡. (Voluta turbinellus. *Linn.*)

Shell ovate-turbinated, subtriangular, transversely sulcated, with white turbercles on every side; interstices of the tubercles black; upper part of the last whorl surmounted by thick elongated tubercles, trifurcate posteriorly, and near the base, muricated with other simple tubercles; spire very short, acuminated; columella quadriplicate.

Indian Ocean. Pl. VIII. Fig. 175. 23 Species.

4. Cancellaria §.

Shell oval or turrited. Aperture sub-canaliculate at the base; canal very short or scarcely perceptible. Columella plaited; folds numerous or few, generally transverse; right lip sulcated internally.

Type. *Cancellaria reticulata* ‖. (Voluta reticulata. *Linn.*)

Shell ovate, ventricose, perforate, thick, transversely rugose, reticulated with oblique longitudinal striæ, slightly marked with yellowish white, and red zones; whorls convex; sutures compressed; upper part of the columella smooth, lower portion triplicate.

South Atlantic Ocean. Pl. VIII. Fig. 176. 12 recent species, and 7 fossil.

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* *Babylonian.* Lamarck's 17th species. His type is *P. imperialis.*

† *Dim. of Turbo.*

‡ *Horned.* Lamarck's 7th species; his type is *T. scolymus.*

§ *From cancelli, latices?*

‖ *Reticulated.*

5. Fasciolaria[*].

Shell subfusiform, channelled at the base, no varices; two or three very oblique folds on the columella, near the canal.

Distinguished from fusus by the folds on the columella, and from turbinella by their oblique direction.

Type. *Fasciolaria tulipa*[†]. (Murex tulipa. *Linn.*)

Shell fusiform, ventricose in the middle, smooth, reddish orange-coloured, or marbled with white and red; brown transverse lines at unequal distances; whorls very convex; sutures marginally fringed; base sulcated; lip internally white, striated. *Antilles.* Pl. VIII. Fig. 177. 8 Species.

6. Fusus[‡].

Shell fusiform, or subfusiform, channelled at the base; ventricose in the middle, or lower part; no external varices; spire elevated and elongated; no fissure or sinus in the right lip. Columella smooth. Operculum horny.

Type. *Fusus colus*[§]. (Murex colus. *Linn.*)

Shell fusiform, narrow, transversely sulcated, white; apex and base red; belly small; whorls convex, nodular carinate in the middle; base slender, long; lip sulcated internally, margin toothed.

Indian Ocean. Pl. VIII. Fig. 178. 37 recent species, and 13 fossil.

7. Pyrula.[‖]

Shell subpyriform, channelled at the base, ventricose at the upper part; no external varices; spire short, sometimes flattened, columella smooth. No fissure on the right lip.

The pyrula differs widely from fusus, by its short spire, and by the remarkable inflation of the last whorl, being always at the upper part of the shell.

Type. *Pyrula canaliculata*[¶] (Murex canaliculatus. *Linn.*)

Shell pyriform, ventricose, thin, rather smooth, palish yellow; upper part of the whorls angular, with flattened tops; channels of the sutures distinct; angle of the upper whorls crenate; base rather long.

Canada. Pl. VIII. Fig. 179. 28 Species.

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[*] *From fasciola, a little band.*
[†] *A tulip.*
[‡] *A spindle.*
[§] *A distaff.* Lamarck's third species; his type is *F. colosseus.*
[‖] *Dim. from pyrum, a pear.*
[¶] *Channelled.*

ART. V. *On the native Country of the Wild Potato, with an Account of its Culture in the Garden of the Horticultural Society; and Observations on the Importance of obtaining improved Varieties of the cultivated Plant*[*]. *By* JOSEPH SABINE, Esq., F.R.S., *&c.*

THE possession of the plants of the *Native Wild Potato* has been long a desideratum, and from the great importance and extensive use of the cultivated root, the subject of course became an object of attention to the Horticultural Society. In my communications with the Society's correspondents on the other side of the Atlantic, this was pointed out as one of the most interesting objects to which their attention could be directed; and it is with no small satisfaction that I am able to state that our inquiries have been successful.

Great doubts have existed as to what parts of the new world the natural habitat of the Solanum tuberosum or Potato should be assigned; and the question is even now a matter of discussion among Botanists of the greatest eminence. The vegetable, in its cultivated state, was first known in this country as the Potato of Virginia; I conceive, however, there can be little doubt that the plants which Sir Walter Raleigh found in that colony, and transferred to Ireland, had been previously introduced there from some of the Spanish territories, in the more southern parts of that quarter of the globe; for had the potato been a native of any district, now forming part of the United States, it would before this time have been found and recognised by the botanical collectors who have traversed and examined those countries.

From the Baron de Humboldt's observations on the potato in Mexico[†], it seems certain that it is not wild in the southwestern part of North America; nor is it known otherwise than as a garden plant in any of the West India islands. Its existence, therefore, remains to be fixed in South America, and it seems now satisfactorily proved, that it is to be found both in elevated places in the tropical regions, and in the more temperate districts on the western coasts of the southern part of that division of the new world.

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[*] From the Horticultural Transactions.

[†] *Political Essay on the Kingdom of New Spain.* Black's Edition. Vol. II. page 481.

According to Molina[*], it grows wild abundantly in the fields of Chili, and in its natural state is called by the natives *Maglia*, producing, when uncultivated, small and bitter tubers. The Baron de Humboldt asserts[†], that it is not indigenous in Peru, nor on any part of the Cordilleras situated under the Tropics. But this statement is contradicted by Mr. Lambert[‡], on the authority of Don Jose Pavon and of Don Francisco Zea; the former of whom says, that he and his companions, Dombey and Ruiz, had not only gathered the Solanum tuberosum wild in Chili, but also in Peru, in the environs of Lima; and the latter has assured Mr. Lambert, that he had found it growing in the forests near Santa Fé de Bogota. The above account of Pavon is further confirmed by the evidence of a specimen gathered by him in Peru, and now forming a part of the herbarium of Mr. Lambert, with the name of "Patatas del Peru."

Mr. Lambert, in his communication to the *Journal of Science and the Arts*, which I have referred to, supposes that the wild potato is to be found on the eastern, as well as the western and northern sides of South America. His opinion on this point appears to have been founded on the following circumstances:

Among the specimens in the Herbarium formed by Commerson, when he accompanied Bougainville in his voyage round the world, is one of a Solanum, gathered near Monte Video. In the *Supplement to the Encyclopédie*, (Vol. III. p. 746), this specimen was described, on the authority of M. Dunal of Montpelier, as belonging to a species distinct from Solanum tuberosum, under the name of Solanum Commersonii, and it was subsequently published by M. Dunal, with the same name in the *Supplement* to his *Solanorum Synopsis*[§]. (The article from the Encyclopédie is given below[‖]). Mr. Lambert, however, conjectured this specimen to be that of the type of the cultivated potato, and was induced to do so by information received from Mr. Baldwin, an American botanist, that he had found the Solanum tuberosum wild, both at Monte Video, and in the vicinity of Maldonado, as well as from Captain Bowles, who had resided a considerable time at Buenos Ayres, and who had told him that this plant was a common weed in the gardens and neighbourhood of Monte Video.

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[*] *Hist. Nat. du Chili*, p. 102.

[†] *Political Essay on the Kingdom of New Spain*. Black's Ed. Vol. II. p. 489.

[‡] *Journal of Science and the Arts*. Vol. X. page 25.

[§] Page 5.

[‖] Morelle de Commerson. Solanum Commersonii. Solanum caule herbaceo, piloso; foliis pinnatis sublyratis, pilosis: floribus corymbosis, terminalibus; pedicellis articulatis. Dun. Suppl. Sol. MSS.

The above statements certainly confirm the existence of a plant in sufficient abundance near the shores of the Rio de la Plata, which Mr. Lambert identifies with Commerson's specimen; but the proof that it is the Solanum tuberosum, in opposition to the decision of Mr. Dunal, rests only on the opinion of Dr. Baldwin, and Captain Bowles, without the usual satisfactory evidence of specimens, which have not been supplied by either of these gentlemen.

In order to elucidate the question as much as possible, I applied to M. Desfontaines, Director of the Museum of Natural History in the Jardin du Roi at Paris, for permission to have a drawing made of Commerson's original specimen, which was deposited in the Herbarium under his charge. With a liberality and kindness which I cannot too highly compliment, the entire specimen was, without delay, transmitted to me. It has much the appearance of being in a dwarf or stunted state. The label affixed to it is thus described: "Hispanis Tomates—flores sunt palliduli—de la plage du pied du Morne de Monte Video en Mai, 1767." The size of the blossom is evidently larger than that of the S. tuberosum, under similar circumstances; the depth of the divisions of the flowers, and the larger proportional size of the terminal leaf, present striking differences from correspondent parts of the common potato.

Toute la plante est converte de poils simples; elle a les plus grands rapports avec le Solanum tuberosum; elle en diffère, 1°. par ses feuilles profondement pinnatifides comme celle de la Pomme de terre, mais dont les folioles sessiles ne sont pas alternativement inégales. 2°. par la foliole impaire, qui est très grande. 3°. par la corolle, qui est à cinq divisions non à cinq angles. La racine de cette plante est encore inconnue.

Very little hairiness is perceptible on the specimen, which, if it had been taken from a plant of S. tuberosum, would probably have been much more hairy, as it usually is when stunted. It is also somewhat singular that Commerson, who could not but know the S. tuberosum and its various names, should have affixed that of "Tomates" to his specimen; this makes it almost certain that he did not consider it to be the potato. On these grounds I have ventured to hesitate in concurring in the opinion of Mr. Lambert, that we have sufficient evidence of the growth of the wild potato in the neighbourhood of the Rio de la Plata. It possibly may be found there, but its existence in that part of America is not proved, since it seems tolerably certain that Commerson's plant is not it, and Mr. Lambert does not suppose that the plants seen by his correspondent and friend were different from Commerson's.

Early in the spring of the present year, Mr. Caldcleugh, who had been some time resident at Rio Janeiro, in the situation of Secretary to the British Minister at that Court, where he had been indefatigable in his exertions to forward the objects of the Horticultural Society, returned to England, having previously taken a journey across the country, and visited the principal places on the western coasts of South America. Among many articles of curiosity which he brought with him, were two tubers of the wild potato, which he sent to me with the following letter:

Montague Place, Portman Square, February 24th, 1823.

My dear Sir,

It is with no small degree of pleasure that I am enabled to send you some specimens of the Solanum tuberosum, or Native Wild Potato of South America.

It is found growing in considerable quantities in ravines in the immediate neighbourhood of Valparaiso, on the western side of South America, in lat. 34½ S. The leaves and flowers of the plant are similar in every respect to those cultivated in England, and elsewhere. It begins to flower in the month of October, the spring of that climate, and is not very prolific.

The roots are small and of a bitterish taste, some with red and others with yellowish skins. I am inclined to think that this plant grows on a large extent of the coast, for in the south of Chili it is found, and called by the natives *Maglia*, but I cannot discover that it is employed to any purpose.

I am indebted for these specimens to an officer of His Majesty's ship Owen Glendower, who left the country some time after me.

I am, my dear Sir, ever sincerely your's,
ALEXANDER CALDCLEUGH.

The two tubers were exhibited to the Society, and a drawing made of them before they were planted. Had there been a third, I should have been tempted to have satisfied myself as to the real flavour, which Mr. Caldcleugh, as well as Molina, describes as bitter. They were planted separately in small pots, and speedily vegetated; they grew rapidly, and were subsequently turned out into a border at about two feet distance from each other, when they became very strong and luxuriant. The blossoms at first were but sparingly produced, but as the plants were earthed up they increased in vigour, and then bore flowers abundantly; but these were not succeeded by fruit. The flower was white, and differed in no respect from those varieties of the common potato which have white blossoms. The leaves were compared with specimens of several varieties of the cultivated potato, which generally were rather of a more rugose and uneven surface above, and with the veins stronger and more conspicuous below, but in other respects there was no difference between them. The pinnulæ which grew on the sides of the petiole, between the pinnæ of the leaves, were few, not near so numerous as in some varieties of the cultivated potato; but in specimens of other varieties that were examined, their leaves were destitute of pinnulæ, so that the existence of these appendages does not appear to be so essential a characteristic as has been supposed, and as is stated in the *Supplement to the Encyclopedie.*

The earth with which the plants had been moulded up had been applied in considerable quantity, so as to form a ridge, the sides of which were full two feet high; and about the month of August, runners from the roots and joints of the covered stems protruded themselves towards the surface of the ridge in great numbers, and when they reached the light, formed considerable stems, bearing leaves and blossoms, so that at length the two plants became one mass of many apparently different plants issuing from all sides of the ridge. The appearance of these runners in such quantities induced a doubt as to the identity of the plant with our common potato, which doubt was increased when it was ascertained, that so late as the month of August no tubers had been formed by the roots. The runners were, however, no otherwise different from what are formed by the cultivated potato under ground, except that they were more vigorous, as well as more numerous.

The plants have recently been taken up, and all doubt respecting them is now removed; they are unquestionably the Solanum tuberosum. The principal stems, when extended, measured more than seven feet in length; the produce was most abundant, above six hundred tubers were gathered from the two plants; they are of various sizes, a few as large or larger than a pigeon's egg, others as small as the original ones, rather angular, but more globular than oblong; some are white, others marked with blotches of pale red or white. The flavour of them when boiled was exactly that of a young potato.

The compost used in moulding up the plants was very much saturated with manure, and to this circumstance I attribute the excessive luxuriance of the growth of the stems; had common garden mould been applied, they would not probably have grown so strong, and I suppose that whilst the plants were thus rapidly making stems and leaves, the formation of the tubers was delayed, for the production of these has been the work of the latter part of the season; they cannot be called fully ripe, nor have they attained the size which they probably might have done if they had been formed earlier.

They will, however, answer perfectly for the purpose of reproduction (or for seed, as it is technically called), and they are in sufficient plenty to be subjected to treatment similar to a common crop of potato. The result of another year's experience is necessary to enable us fully to observe on the merits and value of this new introduction; but the following changes already appear to have attended its subjection to cultivation;—the produce is most abundant, the tubers have lost all the bitterness of flavour which is attributed to them in the natural state, and their size is increased remarkably; from all which circumstances I am disposed to infer, that the original cultivators of this vegetable did not exercise either much art or patience in the production of their garden potatoes.

The increased growth of the potato, not only in these kingdoms, but almost in every civilized part of the globe, has so added to its importance, that any information respecting it has become valuable; the subject of this communication may therefore not be without interest. With the exception of wheat and rice, it is now certainly the vegetable most employed as the food of man; and it is probable that the period is at no great distance, when its extensive use will even place it before those which have hitherto been considered the chief staples of life. The effect, of the unlimited extent to which its cultivation may be carried, on the human race, must be a subject of deep interest to the political economist. The extension of population, will be as unbounded as the production of food, which is capable of being produced in very small space, and with great facility; and the increased number of inhabitants of the earth will necessarily induce changes, not only in the political systems, but in all the artificial relations of civilized life. How far such changes may conduce to, or increase the happiness of mankind, is very problematical; more especially when it is considered, that since the potato, when in cultivation, is very liable to injury from casualties of season, and that it is not at present known how to keep it in store for use beyond a few months, a general failure of the year's crop, whenever it shall have become the chief or sole support of a country, must inevitably lead to all the misery of famine, more dreadful in proportion to the numbers exposed to its ravages.

Under such circumstances, and with such a prospect, it is surely a paramount duty of those who have the means and power of attending to the subject, to exert themselves in selecting and obtaining varieties of potatoes, not only with superior qualities in flavour and productiveness, but which shall be less subject to injury by changes of weather when in growth, and which may possess the quality of keeping for a length of time, either in their natural state, or under the operation of artificial treatment. This is one of the objects to which the care and energies of the Horticultural Society ought to be directed. Under its auspices, and by its means, some new kinds have been brought into notice, but a wide field of exertion is still before it. With the potatoes cultivated in South America at the present time we are very little acquainted; there is one especially which has been heard of, but which has not yet reached us, known at Lima as the yellow or golden potato, and which is reported to be far superior in flavour to any now grown in Europe.

On the subject of the potato there is also a point of curiosity and much interest open to those who have leisure and opportunity of conducting the investigation. Several accounts of its introduction into Europe, and especially into Great Britain and Ireland, are before the public, differing from each other, and none exactly correct; the entire truth is probably to be extracted from the whole, and ought to be supported by references to the original authorities for the different facts. To these, in order to render the early history of the potato complete, an account of its original discovery, and the observations made on it by the first and early visitors to the shores of South America, should be obtained; and this research would probably lead to a detection of the circumstances attending its first introduction into Virginia, which is at present involved in obscurity.

Art. VI. *Observations on the Project of taking down and rebuilding London Bridge.*

[By a Correspondent.]

It is a matter certainly of great interest to men of science, to know what effect the removal of a dam producing a fall of water westward at high water sometimes of two feet, and eastward at low water sometimes of nine feet, from a great river like the Thames, would have westward and eastward of that dam in respect to the bed and shores of such a river; and whether a more frequent inundation and saturation with water of the low lands will cause miasms and pestilential diseases again to prevail, should the means of stopping such inundations or of quickly draining off the water not be immediately obtained. They look forward with great anxiety to the experiment; and the knowledge that this dam has existed many centuries, that the river passes through a dense population, that the estates of individuals have been regulated by it, that the levels of the lowest floors of houses and those of the streets in the low lands adjacent, have reference to this habit of the river, adds much to the excitement; for the intenseness of the interest always increases with the hazard of the throw. The complaints of the inhabitants on the banks of the river, like those of the dumb creature subject to the knife of the surgeon, are not heard in the eager pursuit of knowledge, and in the speculation of future amelioration. There are others who have great influence, and are urgent for the demolition of London Bridge, looking to their own gain in the erection of a new one. A mathematician, like to him of Laputa, has brought his implements to the question, and, without sections, without levels, and ignorant of the soil over which the river flows, or against which it impinges at its sinuosities, knowing neither what may be overflowed, nor what may be sapped, has, by a kind of intuitive philosophical tact, determined that, after the removal of the dam, the stream will flow on as harmless and obedient as heretofore*. Presuming there may be some of your readers unable to discover truth except by induction, and others costive of their belief in the delirations even of a great teacher, and thinking that they may be desirous of viewing this important question by any glass, however weak its power, your correspondent ventures to offer that by which he views the question, and solicits the shelter of a few pages for the following observations in your journal.

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* See Dr. Hutton's Answers, App. 4th Report, 1821.

The writers on the ordinances of rivers consider the courses and velocities of them dependent on the nature of the ground over which they pass, as well as upon the heights from which their waters descend. For example, water descending from a height on rocky ground, which it cannot remove, rises, spreads, and forms a lake; and proceeds with diminished velocity to the lowest point, and there cascades; advancing at the rate of forty-five inches per second, it will drive flint stones about the size of an egg before it, and rise and spread until its velocity is reduced to thirty-six inches per second, when the stones remain at rest; proceeding among pebbles about an inch diameter, it serves them the same, rising and spreading until its velocity is reduced to twenty-four inches per second, when they remain at rest; proceeding through coarse gravel about the size of a marble, it serves it the same, rising and spreading until its velocity is reduced to twelve inches per second; and so it proceeds with diminished velocity according to the size of the grain, the velocity and the course always varying with the obstacles met with. Gravel, the grain being about the size of aniseed, will be at rest at a velocity of four inches per second; sand will remain at rest at a velocity of seven inches per second, and precipitate at six inches per second. Clay will remain at rest at a velocity of three inches per second*. By reference to the map of the river Thames west of London Bridge, and bearing the above-mentioned facts in mind, it will appear that the banks of the river from Nine Elms, a little above Vauxhall Bridge, to London Bridge may be considered artificially fenced, and only requiring additional aid by raising and wharfing to prevent over-flowing and sapping, through any increased height and velocity of the current; and, consequently, as the waters will not be allowed to spread in a neighbourhood where land is so valuable, the bed of the Thames in this part must be deepened naturally if the current acquires increased velocity; and, therefore, the bridges in this part, especially Vauxhall and Westminster Bridges, which do not stand upon piles, must be secured. If proceeding from Fulham and impinging on the shore of Wandsworth and Battersea*, the water should find the soil less resistive than on the opposite bank of the Grove, Chelsea, and Ranelagh, and the banks be not artificially strengthened, the water may take a short cut at some high flood in its course to the sea from Fulham to Nine Elms, and place Battersea in Middlesex. The same principles will apply both to the effects of the flood and ebb tides, from an increased velocity, at the several bendings of the stream, and, without expensive wharfings and continual care after the dam is removed, the proprietors of lands on the river shores, where there are elbows, may expect sometimes to lose a rood, and sometimes an acre of their lands, together with their sheep and cows.

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* See *Principes d'Hydraulique*, par M. le Chev. Du Buat; *Expériences sur les Cours des Fleures*, par M. Genneté; and the article River, *Ency. Brit.*

The present turbidness of the river, and the frequent shifting of some of the banks and shoals, shew it to be now sometimes at variance with its bed and banks. Hence it is necessary to ascertain the nature of the soil of the bed of the river and of its banks at the several points of sinuation up as high as Tide-end-town, wherever it may be hereafter, whenever there are buildings to be sapped †; and this inquiry should be made in the survey, which, by an extract from the report of Mr. Telford in the *Phil. Mag.* of May last, he has requested authority to get made, complaining that no such document exists; the persons examined before him since 1800 up to this session of parliament, as to the effect likely to be produced by the enlargement of the water-way of London Bridge having been able to decide upon these matters without the data Mr. Telford now thinks necessary. Such a river as the Thames, which, at a mean width between London and Blackfriars Bridges, even now the dam exists, having a velocity in the mid stream of sixty-three[*] inches per second, or $3\frac{6}{10}$ miles per hour, at half flood, requires some respect to be paid to its speed, its windings, and its fences, and will be found indignant to an alteration of its ancient habits. The paradoxes which experiments on the flowing of waters present, the recent history of the Eau Brink as to its anticipated and its actual effect on the harbour of Lynn, the erroneous calculations of the Royal Academy of Paris in respect to the apparently simple question of the Paris aqueduct, and those of Desaguliers and M'Laurin as to that of Edinburgh, might cause some doubt of any opinion with sufficient data, and much more of the determinations of mere theory, from one of very advanced age, without any. The question relating to the effects of the removal of the dam westward, put in the following manner, would cause more inquiry than the present seems to have done.

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* The river here is comparatively rough and rapid. The boatmen have a story, that a band of fiddlers at this place were in former times drowned, and that the river has been dancing here ever since. Another band are determined to make the land join in the jig.

† See Appendix, (A. 23, 3d Report. Lond. Port.,) in which are given the bornings from London to Blackfriars' Bridge, from which it appears that the bed of the river, in that part, is gravel and sand, coarse and fine.

What effect would the introduction of another river on the west side of London Bridge, of the same dimensions as the river Thames at London Bridge, with a fall into it of two feet, have upon the bed and banks westward at high water? What effect would the subtraction of a quantity of water, at low water, equal to the surface of the river, six feet in depth at that subtraction, have upon the river westward at that time of the tide? It has been maintained, with reference to a compensation clause in the bill for the new bridge, that, in cases of land-floods, the removal of the dam of London Bridge would not cause an increased height of the waters in the up country, but have a contrary effect. This position is true at all times of the ebbing, but not of the flowing; a high sea-flood meeting a high land-flood must dam back the latter, and at times two feet higher than at present, when the dam of the bridge is removed. For example, on the 28th of December,

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[*] See 3d Report, Appendix. G. London Port, and Plate 20, Appendix. At Westminster, Mr. Labelye ascertained the velocity to be thirty-six inches per second.

1821, from the freshes, the whole of the up-country was so flooded that the inhabitants of the low-lands adjacent used boats in the streets; a sea-flood meeting such a flood, and suffered to rise two feet higher than it can at present, would have caused a greater extent of country to be flooded than suffered at that time *.

Those who favour the removal of the dam of London Bridge, should, during the present hot weather, take a boat at low water from London Bridge, and proceed up the river; and, whilst they enjoy the odour from the banks, contemplate the effects of lowering the water from four to six feet, consequent on such removal, occasionally requiring the boatman to sound the depth with his oar; it will then be manifest to them what a stinking ditch the river will become at low water. Though an expenditure of a large sum of money might dredge out a temporal channel for the navigation at that time, it must nevertheless be remembered, that the width of the river increases upwards from London Bridge, and there are no moveable dams, for which purposes the ships below London Bridge are used to keep it clear. The cause assigned for taking down London Bridge is as follows; "Whereas the great fall of water at certain times of the tide, occasioned by the large starlings and piers of the said bridge, renders the navigation through the said bridge dangerous and destructive to the lives and proper-

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* The late Mr. Mylne's Report, Appendix (A 1) and Plate 1, 3d Report. London Port, without data, but from a practical tact, confirms the opinions contained in this paper. He was employed with a view to the demolition of London Bridge, and was a strenuous advocate for a new one. He contemplates the inadequacy of the sea-walls, but leaves, like the new bill, the care of them to the respective owners. If we may rely on the effect of the increased velocity on the bed of the Thames, which he anticipates, there will, soon after the dam is removed, be the materials of two or three bridges ready wrought at London Bridge for the new structure, without the trouble of stopping the receipts of the excise and customs of the three kingdoms. The fall of water, westward of London Bridge, has dug out the bed of the river, to a distance of four hundred feet, of twenty-eight feet in depth at the lowest point; and that, eastward from the ebbing and freshes, has dug out the bed of the river to a distance of six hundred feet, of thirty-four feet in depth below the bed at the lowest point; when the dam of the bridge is removed, this power will be principally spent in deepening the river upwards. The maintaining Blackfriars Bridge, even with the present bed of the river, ought to be more an object of solicitude than the destruction of London Bridge; its piers are in a very dilapidated state,—and it is to be remembered that the piles under them were not driven nor cut off within coffer-dams.

ties of His Majesty's subjects." By reference to the reports of the Committees of the House of Commons, of the sessions 1820 and 1821, relating to this bridge, ordered to be printed May and June, 1821, and upon abstracting from the evidence therein, relating to the loss of life and property in the last twenty years, the promoters of the demolition of the bridge cannot produce a statement of a greater number of persons drowned than 17, nor damage to property exceeding 4000*l.* by accidents at London Bridge, during that time. The evidence, with respect to the danger of the navigation through the bridge, of the lightermen examined, many of whom have navigated the river for forty years, is directly at variance with the opinions of those who are desirous of a new bridge, and attributes the accidents which occur to mere ignorance and drunkenness.

The sufficient stability of this bridge was ascertained in 1759, when the large arch was made, and unquestionably confirmed by the late examination of the structure of the piers *.

The sufficient width of the bridge as a roadway, is maintained by Mr. Rennie's evidence, (16th April, 1821,) who, upon being asked, "What would you propose to make the width of the new bridge?" answered, "The same width as the old one;" and added, London Bridge is wider than either Southwark, Blackfriars, or Waterloo Bridges. The width of the bridge, in the clear of the parapets, in the design which received the first premium, is only 44½ feet, a less width than between the parapets of the present bridge †; so that the mechanics and tradesmen who urge the necessity of a new bridge, in the hopes of having a freer thoroughfare for themselves and their carts, will be grievously disappointed.

In the late application to architects and engineers, it seems remarkable, that it had not occurred to the bridge committee, that the supposed evil might have another remedy than a new bridge; and out of the course of ordinary proceeding. It might have suggested itself to some engineer, contemplating the direction of the mid stream of the Thames towards Pepper-alley stairs, and the bank of gravel that directs it in that course; or to some antiquary, who recollected King Canute's mode of conveying his fleet from the east side to the west side of London Bridge; or the direction of the cut which was made in 1173, when this bridge was rebuilt,—that an auxiliary cut, and bridge, round the foot of the present structure, north of Tooley-street, might be a cheaper mode of obtaining the proposed object than a new bridge; especially upon finding, upon inquiry, that between the linear waterway (690 feet) required, and the absolute linear waterway of the present bridge, (545 feet,) there is only a deficiency of 145 feet; and between the superficial waterway of London Bridge, and that of the section of the whole river, from Old Swan-stairs to Pocock's Flour wharf, at high water, there is only a deficiency of about 4000 feet.

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* Appendix, Report on London Bridge, 1821, p. 66, *&c.*

† See Mr. Dance's section, Append. B. I. 2d Report, London Port. By Append. B. III. 3d Report, London Port, London Bridge is 45 feet wide, Blackfriars 41 feet, Westminster 39 feet 9 inches.

The late Mr. Mynle (App. B. II.) thought 50 feet a proper width for the new London Bridge. The roadway of Waterloo Bridge is 28 feet, the footpaths each seven feet, together 42 feet; the same as Westminster Bridge is stated to be by Mr. Labelye. Vauxhall Bridge has a roadway of 28 feet, and two footpaths of 5 feet 6 inches each, together 39 feet.

Others, deprecating the removal of the dam, but desirous of rendering the navigation, even when intrusted to unskilful and drunken lightermen, safe, and accustomed to view the locks on other rivers, and even upon this, may surmise, that the object might be obtained by locks *.

The cost of the repairs of this bridge annually, for the twenty years previous to 1818, varied between 6027*l.* and 1455*l.* The income of the estates applicable to the repairs of the bridge, for 1818, is stated to be 26,526*l.*, of which about 11,000*l.* were expended in management. The trustees, also, possessed stock and cash to the amount of 112,000*l.* It was intended that the corporation of London should take up the money, for the purposes of the new bridge, on the security of the Bridge House estates; but as they only produce an annual income of about 26,000*l.*, of which 11,000*l.* are required for management, there only remained 15,000*l.* per annum to pay the interest of money to be borrowed; and allowing the appropriation of a part gradually to pay off the principal, it became manifest, that the estates would not be security for more than 250,000*l.*, which, added to the 112,000*l.* in hand, afforded from these estates only 360,000*l.* towards the new bridge; this sum has wonderfully increased since 1818, so that the corporation are now able to give 200,000*l.*, and raise 400,000*l.*, and reserve for management, *&c.*, 12,000*l.* per annum. Government is to give, also, 150,000*l.*, divided into annual payments, in seven years; during which time the public are to submit to the nuisance, both in respect to the navigation, and the thoroughfare over the river. Hence it appears, that there are about 750,000*l.* in embryo for the new bridge, squaring, of course, with the estimates; but, upon referring to the bill brought into parliament this session, for rebuilding London Bridge, there seems to have been originally some doubt as to the sufficiency of means *; for it will be found, that the commissioners of His Majesty's Treasury were to be allowed to issue exchequer bills for the approaches, and they were also to be allowed to pay the expenses of the act, and direct taxes were to be levied on the public, *on coals and wine* imported into the city of London, for liquidating and paying the interests of these Exchequer bills, under the screen of what is called the Orphans' Fund, and *indirectly, by the introduction of a clause to exempt the corporation "from the payment of any damage to persons, or their houses, estates, vessels, or property,* by reason of the increased rise of the tide of the said river above the said bridge, or the alteration of the channels or currents of the said river, or of the want of water for navigating the same; nor for any *nuisance, obstruction, or injury*, to be occasioned thereby *."

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* Had the instructions to these candidates been unfettered, there might have been a renewal of Messrs. Douglas and Telford's scheme for a cast-iron bridge of 600 feet span, with a rise of 65 feet above high water, for vessels to sail above London Bridge, and only at the cost of 262,289*l.* The practicability and advisableness of this bridge was certified by twelve out of fifteen mathematicians and engineers, though, at that time, neither the designers, nor the committee, nor any of the mathematicians or engineers, knew the strength of cast iron; and those who supposed they knew something of the matter, thought it forty times stronger than it since has been found to be: so easy is it to ask and receive opinions. But where a favourite object is to be carried, the data, upon which such opinions must be founded, are kept out of sight or misstated or an inquiry into them is refused.

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* The amended bill makes the doubt approach to a certainty; for it is said to contain a specific clause, that no one shall be entitled to compensation for any nuisance, obstruction, or injury, on account of the bridge remaining unfinished, in case the sum or sums of money, to be raised and advanced, prove insufficient to complete the same.

But it being understood that the direct taxes might be indigestible, that part of the bill is struck out, and a less visible mode of taxation is to be adopted, by allowing the Commissioners of Customs and of Excise, of England, Ireland, and Scotland, with consent of the Lords of the Treasury, to remit taxes on stone, brick, timber, or other materials used in building the bridge, and its *appurtenances.* For this purpose, the ordinary course of government is to stop, and there is to be a particular interposition; but the poor people, who may be ruined in their fortunes, diseased by the damps and miasms caused by the saturation of their habitations by frequent floods, or overwhelmed by floods, from an inability to provide against them, consequent on this revolution of the ancient, and now constitutional, habit of the river, are left to the care of a higher Power, who has set his bow in the heavens as a token. The scheme seems now to be, to pass the act and get up the bridge, relying, in the case of a deficiency of money to rebuild it, that government would be compelled, by the urgency of the occasion, to provide the means. Such a scheme, in respect to the Post-office, failed: but that was a singular case, an exception to the general success of such policy.

The new bridge, proposed by the late Mr. Rennie, was estimated by him to cost		£430,000
A temporary bridge		20,000
The purchase of property for approaches,	On the north side . . .	150,000
	On the south side . . .	150,000
		£750,000
This sum, by reference to absolute costs, compared with estimates of other works of the same kind, might with propriety be taken as half the cost, even could we not see the causes from which such an excess would arise, *viz.*, at		£1,500,000

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* Those who have built their houses low in the low-lands, and feed their cattle there, the proprietors, and others, who have allowed the foundations of their bridges to be laid at an insufficient depth, are informed that they came to the river, and not the river to them; and that they ought, in choosing such a neighbour, to have provided against such an event as the proposed alteration of the habits of it.

But we have the following items* of charge, by which we may guess that doubling the estimate will be found too small an allowance for contingencies.

1. The bridge is to be erected in a hole where the depth of water, at high water, is 46 feet.
2. The approaches are to be made through property of great value, and in a thoroughfare of persons and carriages as close as sheep in a flock.
3. On removing the old bridge.
4. On raising about 40 miles of river wall, varying from 24 to 26 inches in height, and strengthening the banks by wharfing and piling, in order to provide against the effects of frequent floods, expectant on giving a freer water-way, and increased velocity and height, to the current.
5. On dredging out a channel for the current at low water, for the navigation.
6. On the necessity of narrowing the river in several parts.

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* Many great losses will be sustained by individuals under the heads of these items, but for which, they will be shut out from having any compensation from the city; nevertheless, they must be considered part of the cost of the new bridge. It may be proper to inquire, who are to be subject to these actions, suits, indictments, claims, and demands, which are thus shifted from the mayor, commonalty, and citizens? On the northern shore, we find, among others, the Duke of Northumberland, the Rev. William Lowth, the Duke of Devonshire, the owners of Fulham Town Meadow, Viscount Cremorne, Lord Cadogan, Lord Grosvenor, the Chelsea Water-works Company, the Crown, and others.

From Teddington eastward to Cotton stairs, near Westminster Bridge, all the river walls are defective in height to resist such a flood as that of the 28th December, 1821, that deficiency varying from one foot at Twickenham, to two feet five inches at Cotton Garden stairs; but, generally, in the less populous parts westward, the walls are from three to five feet below that level; while the lands in the populous parts northward are greatly below it; for example, Walham-green and Chelsea are from one to five feet below this level. The ground of the Penitentiary is eight feet below this level. The Vauxhall Bridge road, and Tothill-fields, are generally from three to four feet below this level. St. James's Park, on the south side, varies from sixteen inches to eight feet below this level; and there are various defective banks or ways, as far eastward as the Duchess of Buccleugh's, for the water to get to these parts: It will be the duty of the commissioners of sewers forthwith to give notice to the various proprietors to repair their banks, by raising or otherwise; and it will be a matter determinable by the custom or peculiar laws of the commissioners, whether, in default of complying with such notices, the commissioners may direct the proper raisings and wharfings to be done, and rate the proprietors of the banks for the cost, or leave them to the actions, suits, indictments, *&c.*, of which the mayor and commonalty are so apprehensive.

After the demolition of the dam of London Bridge, this level will be that of not a very uncommon high sea-tide, west of London Bridge.

7. On removing shoals and sand-banks, caused by the alteration in the directions of the mid stream.
8. On the erection of starlings round the piers of the different bridges, and especially round Vauxhall and Westminster bridges, which do not stand upon piles. The bridges above London bridge generally stand in shallow water, and the foundations of them are very little below the bed of the river, which may be undermined; for a greater depth must be effected artificially, in the first instance, for the navigation, and subsequently, by the increased velocity of the stream, in a manner which cannot now be guessed at [*].
9. On the necessity of erecting another dam, or locks, to keep up the water, as a substitute for the dam taken down, the necessity for which, the locks up the river, beginning at Teddington, prove [†].
10. On the damage to shipping below the bridge, in times of frost, by ice now stopped, at such times, by London bridge.
11. On compensations to persons possessed of wharfs, adapted to the present state of the river above and below the bridge, for damage to them by the alterations in the course of the stream, and the shifting of the sand banks.
12. On compensation to persons whose trades are dependant on the free thoroughfare over the bridge, living south and north thereof, for seven years, during the erection, or while it remains unfinished for want of funds to complete it.
13. On compensation to persons navigating the river, for property destroyed, and loss of life, during the erection of the bridge, and while it may remain unfinished for want of

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[*] The head of water maintained by the lock at Teddington in winter is one foot, in summer four feet; a similar head is maintained at Moulsey. Dams are erected here to keep the water up the country; but the dam of London Bridge is to be taken down to let it out.

[†] The bottom of the foundations of the piers of Westminster Bridge are five feet below the bed of the river, allowing two feet three inches, as at Blackfriars Bridge, for grating; the bottom of the stone is only two feet nine inches below the bed. The bottom of the foundations of the piers of Blackfriars Bridge is three feet nine inches below the bed, the bottom of the stone 18 inches. How much below the bed of the river are the foundations of Vauxhall, Waterloo, and Southwark Bridges? The bottom of the stone piers of Waterloo Bridge are only 15 feet below the springing of the arches.

money to complete it, which, at a moderate estimate, may be taken to exceed the same loss arising from the old bridge in the last twenty years.

Hence, in any view of the question, it would be unreasonable to consider the cost of this bridge at less than *one million and a half.*

These observations may probably, through your Journal, cause more inquiry to be made into this important question, than the impatient determination, at any rate to have a new bridge, has hitherto allowed. They may make the failure of the proof of the expediency of removing the dam of the bridge manifest; also shew the deficiency of the means for building the bridge, without taxes to a large amount being eventually levied on the public; and remove the general delusion, that the thoroughfare over the bridge will be more free than it is at present. They may cause some reflections on the forbearance of the government regarding the public dignity, but scrupulous of increasing the public expenditure, in listening for a moment to such an useless and dangerous expense, which, directly or indirectly, will cause taxes to be raised to pay a million at least, **WHILE THE WANT OF A PALACE IS A GENERAL REPROACH TO THE NATION, AND A SUBJECT FOR DERISION WITH EVERY FOREIGNER.**

ART. VII. *Estimate of the Force of Explosion of Coal Gas; laid before the Committee of the Royal Society in the Year* 1814.

[By one of its Members.]

It must be confessed, that without direct experiments on the force of any exploding compound, we can obtain nothing more than probability by calculating from the analogy of other similar effects: but provided that we take sufficient care not to underrate the forces in question, we may obtain, from such a comparison, at least a useful estimate of their greatest possible magnitude.

Dr. Henry has found (*Phil. Trans.* 1808), that good coal gas requires for its combustion, about twice its bulk of oxygen gas, and affords a little more than its bulk of carbonic acid. Now since common air contains only 21 per cent. of oxygen, it can combine with no more than 12 per cent. of coal gas; so that 112 parts of the mixture contain but 33 of substances capable of affording heat, while the remainder tends, in some measure, to impede their union. Hence we cannot suppose the heat, thus generated, to exceed about $\frac{1}{4}$ of the heat which would be excited in a mixture of the gas with pure oxygen. And we shall probably exceed the truth, in allowing to the combustion of such a mixture, a heat equal to that which is evolved in the deflagration of gunpowder; which is sufficient, upon the most probable estimate, to increase in the ratio of 1 to 80, the natural elasticity of the fluids generated, which amount to 250 times the bulk of the powder, so that the elasticity, thus augmented, becomes equal to 20,000 atmospheres. It is true, that some of the solid substances contained in gunpowder may possibly be converted into vapour, and may contribute to its effect: but we have no sufficient reason to believe that the vapours of any of these substances would be more elastic than air; and Count Rumford's hypothesis, concerning the effect of steam, is every way inadmissible; since even if nitre contained water of crystallization, its vapour would be little more effectual than an equal weight of the gaseous substances.

We may, therefore, suppose the exploding mixture to acquire a degree of heat, capable of increasing its elasticity in the ratio of 1 to 20. Dr. Ingenhousz, following Robins, makes the explosive force of a mixture of oxygen and hydrogen equal to 4 atmospheres only: but the assumption of a degree of heat equal only to that, which Robins obtained in a fire, is wholly arbitrary: and a single drop of ether, in a bottle of oxygen, appears to have exploded with a force much more than commensurate to such a cause. On the other hand, when we consider with what safety a mixture of oxygen and hydrogen may be made to explode in a common quart bottle of green glass, we cannot hesitate to allow that 80 atmospheres must be a very ample estimate of the force of explosion of a mixture of oxygen and coal gas. As the ignited gas expands, it loses a portion of its elasticity, not only by the diminution of its density, but also by the effect of the expansion on its temperature, which may be estimated as altering the elasticity in the proportion of the biquadrate root of that of the densities.

Calculating upon these grounds, we find that the whole mechanical power of an explosion of 15,000 cubic feet of a mixture of coal gas, and common air, is equal to that of the explosion of 6 cubic feet, or 4 barrels, of gunpowder; and if we suppose the heated gases in both cases to escape, and mix with the common air in a building containing 30,000 cubic feet, so as to produce an effect commensurate to the temperature of the whole mixture, the explosion of about 15 cubic feet, or 10 barrels of gunpowder, would be required, in order to produce, like the gas, a force of about 10 atmospheres for the whole space. It must, however, be recollected, that gunpowder, thus disposed, is very unfavourably situated for producing violent effects; and that a much smaller quantity, in ordinary cases, would be more formidable than the explosion of the coal gas.

A more precise idea of the effects of such an explosion may be obtained from the calculation of its projectile effects, which would carry some parts of the wall of the surrounding building to a height of nearly 150 yards, and others to a distance of nearly 300. If the walls were in immediate contact with the gasometer, the height and distance would be about twice as great. But a roof of carpentry and tiles being lighter, would be carried higher, while the lateral force of the explosion would be diminished.

Supposing the explosion of the gas to be unconfined, the shock would throw down a brick wall, 9 feet high, and 18 inches thick, at the distance of about 50 feet from the centre; it would probably break glass windows at 150 yards, and at 300, would produce an effect similar to the instantaneous impulse of a very high wind.

CALCULATION.

In order to compare the whole forces of expansion in a confined channel, let the length occupied initially by the gas be a : then, when it becomes ax, the elasticity will be diminished in the ratio of 1 to $x^{-\frac{5}{4}}$; and the force will be expressed by $nx^{-\frac{5}{4}} - 1$, and the fluxion of half the square of the velocity by $nax^{-\frac{5}{4}}\dot{x} - a\dot{x}$; and the fluent will be $-4nax^{-\frac{1}{4}} - ax$, which is initially $= -4na - a$, and finally, when $nx^{-\frac{5}{4}} - 1 = 0$, and $x = n^{\frac{4}{5}}$, and $n = x^{\frac{5}{4}}$, $= -4ax - ax$; and the difference showing half the square of the velocity generated, is $(4n + 1 - 5n^{\frac{4}{5}})\,a$. When $n = 20$, the expression becomes $26a$; when $n = 20\,000$, $66\,204a$; and in order to make these values equal, the latter value of a must be $\frac{1}{2540}$ of the former; and $\frac{15000}{2540} = 5.9$.

In a similar manner, when a is the radius of a sphere, or of a hemisphere, which expands in every direction, the elasticity will vary as $x^{-\frac{15}{4}}$, and the fluxion will be $na\dot{x}^{-\frac{15}{4}}\dot{x} - a\,x$, and the fluent $-\frac{4}{11}nax^{-\frac{11}{4}} - ax$; which, being corrected, gives for the half square $\left(\frac{4}{11}n+1 - \frac{15}{11}n^{\frac{4}{15}}\right)a$.

The fluent, thus found, may be compared with the feet in which the force of gravity would produce an equal velocity, by increasing it in the ratio of the pressure of an atmosphere to the weight to be moved: that is, for a brick wall 18 inches thick, multiplying it by 11: so that, when $n = 20$, and $a = 15$, $.5242a = 865$ feet, the height of ascent: or, supposing the space doubled, and $n = 10$, and a about $18\frac{1}{2}$, the height would be 430 feet.

Where the explosion of the gas takes place without an obstacle, the mean force being about $\frac{5.242}{2.223}$ atmospheres, the velocity of expansion will be about 2000 feet in a second; or, perhaps, a little greater, on account of the lightness of the gas;

but this excess will be compensated, when the velocity is afterwards communicated to the surrounding atmosphere. With this velocity, the centre of inertia of each elementary pyramid of the sphere will advance from the distance $\frac{3}{4} \times 15$ to $\frac{3}{4} \times 33.35$ feet, through $13\frac{3}{4}$ feet, in $\frac{1}{145}$ of a second: and at any greater distance *d*, the velocity of the impulse will be reduced from 2000 to $2000 \times \frac{25}{d}$, or $\frac{50000}{d}$, its duration being always $\frac{1}{145}$ of a second. Thus the velocity of a very high wind being 60 feet in a second, the impulse would retain this force at the distance of 833 feet: and in order to determine at what distance it would overset a wall 9 feet high, and $1\frac{1}{2}$ thick, we must first find the height through which the centre of oscillation of the wall, at $\frac{2}{3}$ of its height, must ascend, in order to be immediately over the point of support, that is $\sqrt{(36 + 1)} - 6 = \frac{1}{12}$ of a foot: and the velocity corresponding to this height would be generated by the force of gravity in $\sqrt{\frac{1}{193}} = \frac{1}{13.9}$ of a second: and in order to be generated in $\frac{1}{145}$, it requires a force 10.43 times as great, or equal to the pressure of a column of brick 15.64 feet high; that is, $15.64 \times 125 = 1955$ pounds for every square foot; which is equivalent to the pressure occasioned by a velocity of 966 feet in a second, and answers to a distance of 52 feet.

ART. VIII. *On the Crystalline Forms of Artificial Salts.* *By* MR. LEVY. *Communicated by the Author.*

THE relation between the chemical composition of a substance, and its crystalline form, has not yet been ascertained; and it is only from a comparative examination of the exact analyses and forms of a great many simple and compound bodies, that it may be expected to be deduced. The data furnished by Mineralogy are not sufficient to discover it; because not only there are too few simple compounds found crystallized, but also because those which are met with have not a sufficient chemical analogy. On the contrary, the composition of the substances crystallized artificially is better known than that of minerals, or at least more easily ascertained; and, perhaps, a sufficient number among them, having a certain desired relation of composition, may be examined, to lead to some important result. It is in this point of view that the determination of their forms appears to me to deserve attention.

This subject has acquired, lately, a new degree of interest, from the two papers of Mr. Mitscherlich. He has himself examined a great many artificial crystals, and has given, in the last of his two papers, it seems, with great accuracy, the forms and complete determination of many salts produced by the combination of the phosphoric and arsenic acid with several bases. His object is to establish, that the same number of atoms, combined in the same manner, produce the same crystalline form; and that the same crystalline form is independent of the chemical nature of the atoms, and is only determined by their number and relative position. In both his papers, and especially in the last, will be found the facts and reasons he adduces in support of this opinion; and, I think, that after their perusal, even those who are most adverse to generalization, must, at least, admit that the analogies and identities of forms, which he has noticed in several compounds, are extremely interesting. Another proposition he advances is, that the same substance may crystallize under two different and incompatible forms; and mentions, as examples, carbonate of lime and arragonite, and the two forms he has obtained for the bi-phosphate of soda*.

The preceding considerations, and the results obtained by Mr. Mitscherlich, made me very desirous to begin an examination of artificial crystals; and having mentioned my intention to Mr. Children, he very kindly offered to take his share of the work, by preparing the crystals, upon the purity of which I could therefore depend. At his recommendation, Mr. Brande has also allowed me to select some crystals from those in his collection, preserved in the laboratory of the Royal Institution, and at Apothecaries' Hall.

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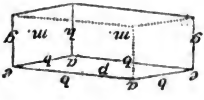
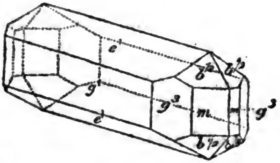
* There is not, however, the same degree of incompatibility between the two forms of the bi-phosphate of soda, as between those of arragonite and carbonite of lime, the one being a right rhombic prism, and the other a rectangular octahedron; but I suppose, Mr. M. has satisfied himself that the one could not simply be deduced from the other.

With this help, I propose to employ some leisure hours to the determination of as many crystallized substances as I shall be able to procure. This paper, and some subsequent ones, will contain the result of my researches. Besides the primitive, I shall give one or two of the forms which most commonly occur. I measure the angles with a goniometer belonging to Mr. Lowry, and which is divided to half a minute; and I besides use the principle of the repetition of angles, in order to obtain a greater accuracy. At the suggestion of Dr. Wollaston, I call the solid, from which the secondary forms are supposed to be derived, by the appellation of *primitive*, when obtained by cleavage; and by that of *primary*, in the contrary case. I designate the angles and edges of the primitive, by the same letters as Haüy; and the secondary planes, by the signs of the decrements from which they are supposed to result.

I have begun with the salts of potash.

Nitrate of Potash.





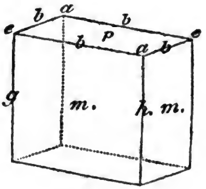
Incidences.

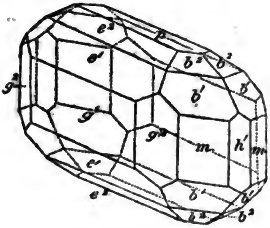
m on *m*	109° 50′
$b^{\frac{1}{2}}$	135 36
g^3	160 42
e^1 on g^1	120 25

Primitive form.—A right rhombic prism, the incidence of the two lateral planes of which is 109° 50′, and the ratio between one side of the base and the height nearly that of 1 to 0,48.

Cleavage.—Parallel to all the faces of the primitive, and also to a plane passing through the two short diagonals of the bases.

Sulphate of Potash.





Incidences.

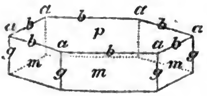
m on m . . .	120°	30′	m on P . . .	90°	0′
b^1 on m . . .	146	22	h^1	123	28
b^2	126	56	b^2	143	4
g^1	119	45	e^1	123	50
g^2	150		e^2	143	17
h^1	150	15			

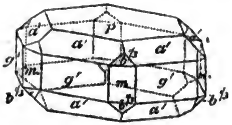
Primitive form.—Right rhombic prism, the incidence of the two lateral planes of which is 120° 30′, and the ratio between one edge of the base and the height, nearly that of 10 to 13.

Cleavage.—Parallel to all the faces of the primitive form, and also to planes passing through both the diagonals of the bases.

In many of the small crystals, the faces P, b^1, b^2, h^1, do not occur.

Hyposulphate of Potash.





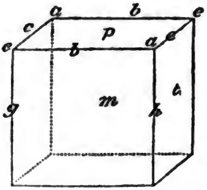
Incidences.

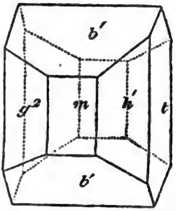
m on m . . .	120°	m on P . .	90°	0′
g^1	150	a^1 . . .	143	22
		$b^{\frac{1}{2}}$ . . .	127	50′

Primitive form.—A regular six-sided prism, in which one side of the base is to the lateral edge in the ratio of 1 to 0,37.

Cleavage.—Parallel to all the faces of the primitive form.

Bi-carbonate of Potash.





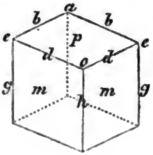
Incidences.

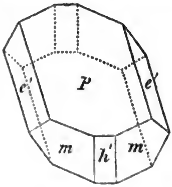
m on t	. . . .	103° 41′
on h^1	. . . .	126 51
h^1 on t	. . . .	156 50
g^2 on m	. . . .	127 33
b^1 on m	. . . .	111 5

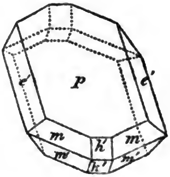
Primitive form.—A right oblique-angled prism of 103° 41′, in which the three edges *b*, *c*, *h* are nearly in the ratio of the number 1, 2,03 and 0,762.

Cleavage.—Parallel to the lateral planes of the primitive, and also to a plane passing through the two edges *g*.

Chlorate of Potash.







Incidences.

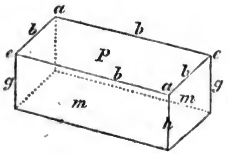
m on m	. . . .	103° 55′
P	. . . .	105 34
h^1	. . . .	141 57 30″
e^1 on P	. . . .	129 50

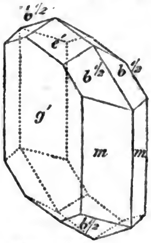
Primitive form.—An oblique rhombic prism, the lateral planes of which are inclined at an angle of 103° 55′; and the base, upon each of the lateral planes, of 105° 34′. The lateral edge is very nearly equal to one side of the base.

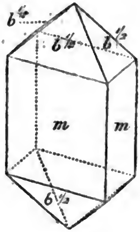
Cleavage.—Parallel to all the faces of the primitive form.

Most of the crystals I have observed were macles as represented in the third figure.

Sub-chromate of Potash.







Incidences.

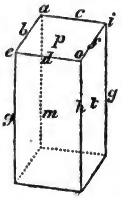
m on *m*	107° 8′
P	90
e_1 on g^1	120 50
$b_{\frac{1}{2}}$ on *m*	130 10

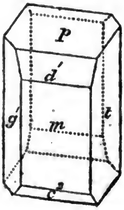
Primary form.—A right rhombic prism of 107° 8′, in which the ratio of one side of the base, to the lateral edge of the prism, is nearly that of 5 to 2.

Cleavage.—None very distinct.

This is the yellow chromate of potash, which, from the remarks of Mr. Taffaert, in the *Annales de Chimie* for 1823, appears to be a sub-chromate.

Bi-chromate of Potash.





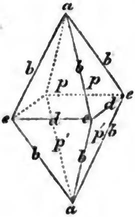
Incidences.

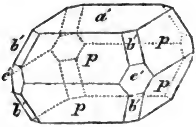
	on *m*	on *P*	on *t*
P	98° 14′	0° ′	91° 36′
m	0	98 14	96
t	96	91 36	0
d^1	142 6	136 8	85 44
g^1	114 33	94 19	149 27
e^2	113 2	31 16	

Primitive form. A doubly oblique prism, in which the incidences of the base *p*, on the two lateral planes *m*, *t*, are, respectively, 98° 14′, and 91° 36′; and that of *m* on *t*, 96°; the lengths of the three edges, *f*, *d*, *h*, meeting in the point *o*, are nearly in the ratio of the numbers 1., 0.55, 1.125.

Cleavage.—Very easily obtained, parallelly to all the planes of the primitive.

Prussiate of Potash.





Incidences.

P on P	98° 11′
P^1	135 40
a^1	112 10
b^1 on a^1	119 57
e^1	90

Primary form.—Octahedron, with a square base, in which the incidence of two adjacent faces of the upper pyramid is 98° 11′.

Cleavage.—Easy, in a direction perpendicular to the axis of the octahedron.

[To be continued.]

ART. IX. *Historical Statement respecting Electro-Magnetic Rotation.* *By* M. FARADAY, *Chem. Assist. in the Royal Institution.*

IN the XIIth Volume of this Journal, at page 74, I published a paper on some new electro-magnetical motions, and on the theory of magnetism. In consequence of some discussion, which arose immediately on the publication of that paper, and also again within the last two months, I think it right, both in justice to Dr. Wollaston and myself, to make the following statement:—

Dr. Wollaston was, I believe, the person who first entertained the possibility of electro-magnetic rotation; and if I now understand aright, had that opinion very early after repeating Professor Oersted's experiments. It may have been about August 1820, that Dr. Wollaston first conceived the possibility of making a wire in the voltaic circuit revolve on its own axis. There are circumstances which lead me to believe that I did not hear of this idea till November following; and it was at the beginning of the following year that Dr. Wollaston, provided with an apparatus he had had made for the purpose, came to the Institution with Sir Humphry Davy, to make an experiment of this kind. I was not present at the experiment, nor did I see the apparatus, but I came in afterwards, and assisted in making some further experiments on the rolling of wires on edges*. I heard Dr. Wollaston's conversation at the time, and his expectation of making a wire revolve on its own axis; and I suggested (hastily and uselessly) as a delicate method of suspension, the hanging the needle from a magnet. I am not able to recollect, nor can I excite the memory of others to the recollection of the time when this took place. I believe it was in the beginning of 1821.

The paper which I first published was written, and the experiments all made, in the beginning of September, 1821. It was published on the 1st of October; a second paper was published in the same volume on the last day of the same year. I have been asked, why in those papers I made no reference to Dr. Wollaston's opinions and intentions, inasmuch as I always acknowledged the relation between them and my own experiments? To this I answer, that upon obtaining the results described in the first paper, and which I shewed very readily to all my friends, I went to Dr. Wollaston's house to communicate them also to him, and to ask permission to refer to his views and experiments. Dr. Wollaston was not in town, nor did he return whilst I remained in town; and, as I did not think I had any right to refer to views not published, and as far as I knew not pursued, my paper was printed and appeared without that reference whilst I remained in the country. I have regretted ever since I did not delay the publication, that I might have shewn it first to Dr. Wollaston.

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* See Sir Humphry Davy's Letter to Dr. Wollaston. *Phil. Trans.* 1821. p. 17.

Pursuing the subject, I obtained some other results which seemed to me worthy of being known. Previous to their arrangement in the form in which they appear at page 416 of the same volume, I waited on Dr. Wollaston, who was so kind as to honour me with his presence two or three times, and witness the results. My object was then to ask him permission to refer to his views and experiments in the paper which I should immediately publish, in correction of the error of judgment of not having done so before. The impression that has remained on my mind ever since, (one-and-twenty months,) and which I have constantly expressed to every one when talking of the subject, is, that he wished me not to do so. Dr. Wollaston has lately told me that he cannot recollect the words he used at the time; that, as regarded himself, his feelings were it should not be done, as regarded me, that it should; but that he did not tell me so. I can only say that my memory at this time holds most tenaciously the following words: "I would rather you should not;" but I must, of course, have been mistaken. However, that is the only cause why the above statement was not made in December 1821; and that cause being removed, I am glad to make it at this, the first opportunity.

It has been said I took my views from Dr. Wollaston. That I deny; and refer to the following statement, as offering some *proof* on that point. It has, also, been said, that I could never, unprepared, have gained, in the course of eight or ten days, the facts described in my first paper. The following information may elucidate that point also:

It cannot but be well known, (for Sir Humphry Davy himself has done me the honour to mention it,) that I assisted him in the important series of experiments he made on this subject. What is more important to me in the present case, however, is not known; namely, that I am the author of the *Historical Sketch of Electro-Magnetism*, which appeared in the *Annals of*

Philosophy, N. S. vols. II. and III. Nearly the whole of that sketch was written in the months of July, August, and September, of 1821; and the first parts, to which I shall particularly refer, were published in September and October of the same year. Although very imperfect, I endeavoured, as I think appears on the face of the papers, as far as in me lay, to make them give an accurate account of the state of that branch of science. I referred, with great labour and fatigue, to the different journals in which papers by various philosophers had appeared, and repeated almost all the experiments described.

Now this sketch was written and published *after* I had heard of Dr. Wollaston's expectations, and assisted at the experiments before referred to; and I may, therefore, refer to it as a public testimony of the state of my knowledge on the subject *before* I began my own experiments. I think any one, who reads it attentively, will find, in every page of the first part of it, proofs of my ignorance of Dr. Wollaston's views; but I will refer more particularly to the paragraph which connects the 198th and 199th pages, and especially to the 18th and 19th lines of it; and also to Fig. IV. of the accompanying plate. There is there an effect described in the most earnest and decided manner, (see the next paragraph but one to that referred to,) my accuracy, and even my ability, is pledged upon it; and yet Dr. Wollaston's views and reasonings, which it is said I knew, are founded, and were, from the first, as I now understand, upon the knowledge of an effect quite the reverse of that I have stated. I describe a neutral position when the needle is opposite to the wire; Dr. Wollaston had observed, from the first, that there was no such thing as a neutral position, but that the needle passed by the wire: I, throughout the sketch, describe attractive and repulsive powers on each side the wire; but what I thought to be attraction to, and repulsion from the wire in August, 1821, Dr. Wollaston long before perceived to arise from a power not directed to or from the wire, but acting circumferentially round it as axis, and upon that knowledge founded his expectation.

I have before said, I repeated most of the experiments described in the papers referred to in the sketch; and it was in consequence of repeating and examining this particular experiment, that I was led into the investigation given in my first paper. He who will read that part of the sketch, above referred to[*], and then the first, second, and third pages of my paper[†], will, I think, at once see the connexion between them; and from my difference of expression in the two, with regard to the attractive and repulsive powers, which I at first supposed to exist, will be able to judge of the new information which I had, at the period of writing the latter paper, then, for the first time acquired.

ART. X. *Proceedings of the Royal Society.*

The following papers have been read at the table of the Royal Society since our last report:

March 6. On a new phenomenon of electro-magnetism, by Sir Humphry Davy, Bart., P.R.S.

13. On fluid chlorine, by Mr. Faraday, communicated by the President.

20. On the motions of the eye in illustration of the muscles and nerves of the orbit, by Charles Bell, Esq., communicated by the President.

April 10. An account of an apparatus, on a peculiar construction, for performing electro-magnetic experiments, by Wm. H. Pepys, Esq.

On the condensation of several gases into liquids, by Mr. Faraday, chemical assistant, Royal Institution, communicated by the President.

17. On the application of liquids formed by condensation of gases, as mechanical agents, by Sir Humphry Davy, Bart., P.R.S.

On the temperature of the Sea at considerable depths, by Captain Sabine.

24. Details of experiments made with an invariable pendulum in various places on the South American station, by Captain Basil Hall, R.N.

May 1. On the changes of volume produced in gases in different states of density by heat, by Sir Humphry Davy, Bart., P.R.S.

His Grace the Duke of Northumberland was elected a Fellow of the Society.

8. Continuation of Professor Buckland's account of the caverns containing bones in England and Germany.

William, Earl of Dartmouth, was admitted a fellow of the society.

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[*] Annals of Philosophy, N. S., ii. 198, 199.

[†] Quarterly Journal, xii. 74—76.

15. Further remarks on the evidence of diluvial action in the caves of Germany, by Professor Buckland.

At this meeting Mr. William Clift was elected into the society.

29. Description of a magnetic balance, with an account of some recent experiments on magnetic attraction, by Mr. W. S. Harris, communicated by the President.

At this meeting of the society the following gentlemen were elected fellows: *viz.*, Peter Barlow, Esq., Arthur de Capel Brooke, Esq., J. S. Harford, Esq., the Rev. Lewis Evans, Samuel Reynolds Solly, Esq., and the Rev. J. M. Traherne.

June 5. A case of pneumato-thorax, with experiments on the absorption of different kinds of air introduced into the pleura, by John Davy, M.D.

On fossil-shells, in a letter to the President, by L. W. Dillwyn, Esq.

John Rennie, Esq. was elected a fellow of the society.

12. On the existence of bitumen in certain minerals, by the Rt. Hon. George Knox, F.R.S.

On the diurnal variation of the horizontal magnetic and dipping needle, by P. Barlow, Esq.

19. On the diurnal deviations of the horizontal needle, when under the influence of magnets, by J. H. Christie, Esq.

Astronomical observations made at Paramatta, communicated by Sir T. Brisbane.

Contributions towards the history of the cocoa-nut tree, by H. Marshall, Esq.

An account of the effect of mercurial vapours on the crew of H. M. ship Triumph, in the year 1810, by W. Burnett, M.D.

On the apparent magnetism of metallic titanium, by W. H. Wollaston, M.D., V.P.R.S.

Tables relating to certain deviations which appear to have taken place in the north polar distance of some of the principal fixed stars, by J. Pond, Esq., F.R.S,. Astronomer Royal.

Account of a case of pneumato-thorax, in which the operation of tapping the chest was performed, with some observations on the power of mucous membranes to absorb air, by John Davy, M.D., F.R.S.

Account of experiments made with an invariable pendulum at New South Wales, by Major-General Sir Thomas Brisbane, K.C.B., F.R.S., communicated by Captain Henry Kater, F.R.S., in a letter to the President.

Second part of the paper on the nerves of the orbit, by C. Bell, Esq.

On astronomical refractions, by J. Ivory, A.M., F.R.S.

On algebraic transformation, as deducible from first principles, and connected with continuous approximation, and the theory of finite and fluxional differences, including some new modes of numerical solution, by W. G. Horner, Esq.

Major-General Sir George Murray was elected fellow of the society.

The Society then adjourned over their long vocation, to meet again on Thursday, November 20.

ART. XI. PROGRESS OF FOREIGN SCIENCE.

1. *On the Cold produced by the Evaporation of Liquids. By* M. Gay-Lussac.

This memoir was read to the Academy of Sciences so long ago as 1815, but its publication was deferred, in the view of rendering it more complete; an intention which its author has not possessed leisure to realize.

The evaporation of a liquid may take place in a vacuum or in a gas. The depression of temperature, which results, differs in these two circumstances. In a vacuum, supposing the vapour to be absorbed as soon as it is produced, the greatest cold takes place for a determinate temperature of the ambient medium, when the caloric absorbed for the transformation of the liquid into vapour is equal to that entering the liquid from the sides of the receiver [*]. For it is evident that, since the latter augments with the difference of temperature between the liquid and the surrounding medium; and as, on the contrary, the elastic force of the vapour goes on continually to diminish, as well as its velocity, (of formation,) there must necessarily be a period, at which the caloric absorbed by the vapour shall be equal to the caloric poured in by the surrounding walls. But if we lower the temperature of the ambient medium, the limit of the cold will retrocede, and it may do so, even indefinitely, whilst the vapour of the liquid shall preserve an appreciable tension. Thus M. Gay-Lussac has frozen mercury with ease, by surrounding with a frigorific mixture of ice and salt, the vessels in which the aqueous vapour was produced and absorbed by the apparatus of professor Leslie; and he does not doubt, that, with analogous means, and very evaporable liquids, we may arrive at a degree of cold much more considerable than by the mixtures.

Suppose, now, that the evaporation takes place in a gas, perfectly dry, of a determinate temperature. Here new causes come to influence the production of the phenomenon, which it is necessary to appreciate.

In the first place, the evaporation is retarded by the gas, which presses on the liquid. It would amount to nothing, in a gas perfectly at rest, whose density, under the same pressure, would be equal to that of the vapour; and the temperature being supposed constant, it would augment nearly in proportion to the velocity of the gas, until this velocity was equal to that which the vapour would assume *in vacuo*. The cold produced by the vapour, depends on it, up to a certain point; for if it were very little, it would be possible, that the heating produced by the surrounding bodies, would be more rapid than the cooling due to the evaporation; and thus, the cold could not reach its limit.

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[*] It is here supposed, that the evaporation takes place over the whole surface of the liquid, as with a thermometer with a moistened bulb. This is the most favourable case for obtaining the *maximum* of cold.

In the second place, the liquid, evaporating only by means of the air, which impels against its surface, cannot evidently cool as much as *in vacuo;* and for a given initial temperature, the cold produced is at its *maximum*, when the caloric, absorbed by the vapour, is equal to that which the air loses, to put itself in an equilibrium of temperature and pressure with it, *plus* the caloric poured into the evaporating surface by the surrounding bodies; but the quantity of the latter, when the cold produced is only a few degrees, is small in comparison of the other, and may be neglected. From the latent heat of the vapour of the evaporable liquid, the law of its elastic force relative to the temperature and its density, on one hand; and, on the other, the capacity of the air for heat, its temperature, its density, and its pressure, M. Gay-Lussac has constructed a formula, for calculating the degree of cold, which should be produced by evaporation. In order to compare his theory with experiment, he determined directly the depression of temperature produced by a current of dry air on a mercurial thermometer, surrounded with moistened cambric. The air issuing from a gasometer, under a constant pressure, passed first through a tube filled with chloride of calcium; from this tube it entered another, where it met a thermometer destined to show its temperature; then five centimetres further on, (two inches E.,) another thermometer with a moistened surface, which it enveloped on every side. Thence, it diffused itself freely in the atmosphere, without suffering further change of pressure. The calculated and experimental results coincide very nearly. We shall content ourselves with giving the latter.

Temperature of the dry air at the pressure of 29.9 inches.	Depression of temperature produced by evaporation below the temp. of the air.
0° C.	5.82° C.
1	6.09
2	6.37
3	6.66
4	6.96
5	7.27
6	7.59
7	7.92
8	8.26
9	8.61
10	8.97
11	9.37
12	9.70
13	10.07

Temperature of the dry air at the pressure of 29.9 inches.	Depression of temperature produced by evaporation below the temp. of the air.
14° C.	10.44° C.
15	10.82
16	11.20
17	11.58
18	11.96
19	12.34
20	12.73
21	13.12
22	13.51
23	13.90
24	14.30
25	14.70

The heat given up by the air, during evaporation, depending evidently on its density, it follows, that, all other things being equal, the cold produced ought to increase as the density diminishes. We have hitherto supposed that the air was perfectly dried; but, if we take it in the ordinary hygrometric state, the cold produced by evaporation will not be so considerable, and it will be even null, where the air is saturated with humidity. The cold is relative to the quantity of water which the air can suffer to pass into the state of vapour; but this quantity is not immediately known, by that already contained in the air, before it arrives at the moist surface. Suppose, in fact, that the temperature of the air is 10° C., and that it is half saturated with humidity; suppose, further, that the cold produced amounts to 4°, it is evident that, at this term, the air which was half saturated with moisture at 10°, will be more highly so on account of the cooling which it has experienced, and that the quantity of water which can evaporate, is precisely equal to what the air wants at the temperature of $10°-4°=6°$, in order to be saturated.

"In general, we may succeed in knowing the hygrometric state of the air, according to the cold produced by evaporation; but as this cold is variable with the pressure of the air, its temperature, its degree of humidity, we would require very extensive tables to determine it with exactness. I was willing to undertake this labour, repeating my experiments on the cold produced by evaporation, and making new ones; but I have been disheartened by its length, as well as the want of sufficient *data*, and especially by the consideration that the ingenious process of Leroi was susceptible of a more easy application, and that in the actual state of physics, it was much preferable." We heartily concur in this preference of M. Gay-Lussac, which brings a strong additional argument in favour of Mr. Daniell's hygrometer, founded on the principle of Leroi, and against Mr.

Leslie's, constructed on the other plan.—*Ann. de Chimie et de Physique*, xxi. 82.

2. *Memoir on the Density of Vapours, by* M. Cés. Despretz.

Although we can find no new facts in this paper, it deserves notice from the mode of investigation. The process followed for comparing the weights of gases, has never been applied to vapours, because it was foreseen, that, on taking the densities at the boiling points of the liquids, the contact of the cool sides of the balloon would cause a portion of vapour to be liquefied. It would not be so, if the experiments were made at the temperature of the surrounding bodies. We might then weigh vapours as we weigh gases. M. Despretz conceives himself to be the first person who has done this. We obtain, adds he, vapour perfectly pure, and at the actual temperature of the surrounding bodies, by fixing a stop-cock to a barometric tube, whose internal diameter is triple that of the ordinary tubes, and by introducing into this tube the liquid whose vapour we wish to weigh. We adapt a balloon to it, well exhausted of air; this is soon filled with vapour; an ordinary barometer is plunged into the same bath, so that we know the elastic force of the vapour weighed, by the difference of height of the mercury in the two tubes. Lastly, we judge if the elastic force is at the maximum, and consequently, if the space be saturated, by the inspection of a third barometer-tube. In this third tube, there is liquid in excess, which will not be the case with the tube which furnishes vapour to the balloon, except in so far as the mercury in it is at the same height as in the first.

We consider the suggestion of M. Despretz ingenious, but the details are obscure. A plate of his apparatus should have been given in the Annales.—*Ann. de Ch. et de Ph.* xxi. 143.

3. *On the Hydriodide of Carbon* (hydriodure;) *a new Mode of obtaining it. By* M. Serullas.

The preparation of the hydriodide of carbon, by the action of potassium on alcohol holding iodine in solution, being practicable by few persons, from the price of potassium, M. Serullas sought to obtain this new body by other and easier means. After different attempts, all founded on the re-action of bodies which could present nascent olefiant gas to iodine, M. S. has succeeded in readily procuring hydriodide of carbon. On chloride of iodine, made by saturating pulverulent iodine with chlorine in a globe, he poured from five to six times its weight of alcohol, at 34°, (about 0.847 sp. gr.) The liquid, at first turbid, became clear in a few instants with deposition of some saline matters proceeding from the impurity of the iodine, as also of a small quantity of an acid iodate having potash for its base, which likewise existed in the iodine.

This alcoholic solution of chloride of iodine being treated with small portions of an alcoholic solution of caustic potash, there was instantly formed a very abundant yellowish, curdy precipitate, composed of a mixture of hydrochlorate and acid iodate of potash. The acid iodate, it ought to be observed, exists only at the commencement. The saturation being continued and pushed to a slight alkaline excess, the liquid, which was strongly coloured at a certain period of the saturation, by the separation of the iodine of the sub-chloride, appeared after some moments of repose above the saline deposit, of a lemon-yellow colour, having the saccharine taste given to it by the hydriodide of carbon, which it holds in solution, along with the hydriodate of potash. We decant and wash the salts several times with alcohol, to carry off the whole of the hydriodide; which is indicated by the alcohol ceasing to be coloured. The salts are set to drain on a filter, and the liquid is united to the other portions, after filtration. We evaporate the liquid at a gentle heat; the hydriodide crystallizes; and we separate it before the entire evaporation of the liquid, by throwing it on a filter and washing it with cold water, till this be no longer affected by nitrate of silver; a proof that the hydriodide is freed from the hydriodate of potash which it might have retained. We separate afterwards, by solution and crystallization, the hydrochlorate from the iodate, which we make use of, converting it into an iodide by fusion.

M. Serullas afterwards contrived the following modification of the process: Into alcohol of the above strength, mixed with much more iodine than it could dissolve, he passed a current of chlorine, which made the colour of the iodine speedily disappear, whose solution was meanwhile aided by agitation with a glass tube. The stream of gas having been continued some instants after the disappearance of the iodine, the yellowish liquor, considered to be then an alcoholic solution of chloride and sub-chloride of iodine, was saturated in the same way as the other, by an alcoholic solution of caustic potash, which immediately determined the formation of the same yellow curdy precipitate containing the same substances: iodate, hydrochlorate of potash, and hydriodide of carbon in solution; the last in as large a proportion as by the process of mingling alcohol with the chloride of iodine separately prepared. The acid-iodate of potash, which instantly falls down, from its insolubility in alcohol, has, like iodic acid, a sharp and astringent, but less intense taste than that of iodic acid. Its solution merely reddens, without destroying, tincture of litmus. This salt is less soluble than the neutral iodate of the same base; and its crystals, when slowly formed, present truncated pyramids, whose base is a rectangular parallelogram, or small prisms, with four very transparent faces, terminated by pyramid of four faces.

M. Serullas conceives that, without the concurrence of potash, the simple act of dissolving chloride of iodine in alcohol, is not sufficient to decompose the water, and produce hydriodide of carbon; for the existence of this hydriodide is not manifested till during the saturation, beginning, probably, at the moment when the iodine of the sub-chloride is set at liberty, and it is only when the saturation is completed, that the liquor acquires the yellow colour, the saccharine taste, and the peculiar odour, which distinguish the hydriodide. Saturation by pure magnesia produces no hydriodide. This compound is solid, of a lemon-colour, and a saccharine taste, which becomes very manifest when it is dissolved in alcohol. It crystallizes in spangles of a brilliant aspect. Its smell is aromatic, approaching nearly to that of saffron. Its specific gravity is nearly double that of water. It is not sensibly soluble in this liquid. It dissolves in 80 times its weight of alcohol of 0.825 sp. grav., at the ordinary temperature; and in 25 times, at a temperature of 95° Fahr. Seven parts of ether dissolve one of hydriodide.

Fat and volatile oils dissolve it readily. In the latter, at least in the essence of lemons, it suffers an alteration; for, on exposure to light, charcoal is evolved, and the iodine becomes free. Sulphuric, sulphurous, nitric, and muriatic acids have no action upon it; nor has a solution of chlorine in water.

Exposed to the air, at common temperatures, it disappears at the end of a certain period. A heat of 212° Fahr. volatilizes it without decomposition; between 240° and 248° it enters into fusion, and is soon afterwards decomposed, giving rise to vapours of iodine, a deposit of very brilliant charcoal, and hydriodic acid. A portion is volatilized at the same time. Of all the simple non-metallic bodies, chlorine, in the state of gas, is the only one which presents, with hydriodide of carbon, very remarkable phenomena.

These two bodies scarcely come into contact before there is a lively action, and sudden decomposition of the hydriodide; whence products result, whose nature varies according to circumstances.

1. If the chlorine, as well as the hydriodide, are perfectly dry, there is formed a chloride of iodine, some muriatic acid, and a peculiar white matter containing much carbon.

2. If the chlorine be in excess, there is a formation of a solid yellow chloride; and one of a subchloride in the opposite case.

3. When the quantity of chlorine which has been made to act upon the hydriodide has been sufficient merely to produce a subchloride, there is no longer found in its watery solution the above white matter, but small quantities of a liquid of an oily appearance, which seems to grease the sides of the vessels,

unites gradually at the surface of the water, and ends sometimes in falling down, and collecting at the bottom, in a drop more or less bulky. The vessels have then a very peculiar odour, approaching much to that of essence of turpentine.

M. Serullas at first imagined, that these two substances might be the chlorides of carbon discovered by Mr. Faraday; but he has not been able to recognise either of the properties by which Mr. Faraday distinguishes them, nor are those which characterize the peculiar matters, similar to those of the species of chloride of carbon, which may be obtained from the action of chlorine on alcohol. It is difficult, however, to believe that there is not an identity of composition between these products; which will be, no doubt, modified by circumstances which he has not been able to appreciate.

To make the experiment of transforming the hydriodide of carbon into the chloride of iodine, we fill a phial, having a ground stopper, with chlorine dried over chloride of calcium, and throwing into it some hydriodide in powder, immediately shut the phial; the action is speedy. There is a developement of heat and a brisk effervescence due, he thinks, to the disengagement of muriatic acid gas, which is formed. We see the liquid red sub-chloride which also is formed at the same time, successively pass, by the absorption of chlorine, into a solid yellow chloride. It is possible, by heating carefully the stoppered bottle, to make the chloride pass alternately from the solid state, to the state of a liquid sub-chloride, which, on cooling, returns to its primitive state by resuming the chlorine which the heat had separated with effervescence. M. Serullas has even employed this means to volatilize the chloride, from one side of the bottles to the other, across the residuary chlorine, in order to be sure of the complete decomposition of the hydriodide. When we project hydriodide of carbon into flasks filled with chlorine, we hear each time a slight noise, similar to that produced by the immersion of a red-hot iron rod in water.

4. If the chlorine employed in these experiments is still charged with the usual humidity which it has in coming directly into the bottles without previous drying, the hydriodide of carbon which we introduce equally gives rise to chloride of iodine, and muriatic acid, but we have no longer the white matter. There is formed in its place chloroxycarbonic gas (phosgene gas) which we can insulate by inverting the bottles first over a mercurial bath, to make the excess of chlorine be absorbed with agitation; then in water, in order to dissolve the muriatic acid. The phosgene gas can remain a sufficiently long time in contact with water without being decomposed, so as to be examined and recognised. This circumstance of the humidity of the chlorine, to which M. Serullas had not paid attention in his first experiments, hindered him, for some time, from recognising under what form

the carbon disappeared, which he knew positively to exist in the hydriodide.

He had occasion to observe, in these experiments, that the sub-chloride of iodine, treated by ammonia, threw down, at the moment, the iodine, in the state of a very fulminating iodide of azote; and that there was formed scarcely any hydriodate of ammonia. We can understand this, since the chlorine, which in this case decomposes the ammonia, ought exclusively to seize the hydrogen, leaving the azote to the iodine. By the common process of putting iodine into water of ammonia, only one-fourth of the iodine is converted into the fulminating compound.

The facility offered by chlorine, of converting the hydriodide of carbon into chloride of iodine, and consequently into iodate and hydrochlorate, by its solution in water, and saturation with potash, appeared to M. Serullas, after other trials, to be the most exact means of ascertaining the quantity of iodine which enters into the composition of the hydriodide of carbon. He treated a number of times with chlorine, given quantities of hydriodide of carbon; the resulting chloride of iodine, being dissolved in water, and saturated with potash, constantly produced the same quantities of iodate, at least with so slight differences, that we may indicate, without fear of deviating from the truth, 1.5 gramme as the mean product, for each gramme of hydriodide. The iodate of potash being formed of 77.54 acid and 22.246 potash; the iodic acid of 100 iodine and 31.927 oxygen; every gramme of hydriodide of carbon will then contain 0.8992 of iodine.

M. Serullas analyzed the compound also, by ignition with oxide of copper; from which he infers it to consist of,

Iodine .	0.8992	1 atom
Carbon .	0.0864	2 atoms
Hydrogen	0.0144	2 atoms.
	1.0000	

Ann. de Ch. et de Phy. xxii. 172.

Supplementary to the above information, M. Serallas has inserted in the same Journal a letter to M. Gay-Lussac, on the subject, in which he says, that he finds hydriodide of carbon may be very abundantly obtained, by simply treating an alcoholic solution of iodine with an alcoholic solution of caustic potash, or soda. The formation of hydriodide of carbon, in this case, proves very manifestly the decomposition of the water; just as the formation of an iodate with excess of acid, from the first instants of the saturation of a solution of chloride of iodine, seems to prove the pre-existence of iodic acid in the solution; and consequently to confirm its being a mixture of iodic acid and muriatic acid, as M. Gay-Lussac has said.

4. *On a Crystalline Matter formed in a Solution of Cyanogen. By* M. Vauquelin.

A solution strongly impregnated with cyanogen, which M. Vauquelin had preserved in his laboratory during the preceding winter, presented a new phenomenon to him, which he had not leisure to examine in his first experiments. At the end of about four months, this solution, become of a slight amber hue, deposited orange-yellow crystals, the number of which increased for some time. When this deposition seemed to have ceased, he examined the crystals, as also the liquor which had produced them.

The latter had an amber colour, diffused a strong smell of hydrocyanic acid, was alkaline, at least it suddenly restored the colour of litmus reddened by an acid. It precipitated the sulphate of iron of a bluish green, which changed instantly to blue by the addition of a drop of sulphuric acid. It is not to be doubted therefore from these experiments that the solution of cyanogen was converted into hydrocyanate of ammonia. It contained likewise carbonic acid, for it precipitated lime water.

Let us next pass to the examination of the properties of the crystals of which we have spoken, and see if by means of their properties, we can come at their chemical composition. 1. These transparent crystals have an orange yellow colour, which yields a lemon-coloured powder; their form is dendritic; they have no marked taste or smell; they are almost insoluble in water; potash ley disengages nothing from them, nor does it dissolve them. The mixture of these crystals and potash gives no Prussian blue with sulphate of iron. Dilute sulphuric and muriatic acids make them experience no alteration.

Placed on burning coals, they volatilize, diffusing a white smoke, and a strong smell of hydrocyanate of ammonia; leaving a very small quantity of black matter, which can be nothing but charcoal.

Heated in a glass tube, closed at one end, into which he had introduced a slip of paper dipped in sulphate of iron, they presented the following phenomena: a little moisture soon appeared, the paper assumed a bluish colour; then a dull white matter sublimed, and there remained in the bottom of the tube only some black grains. When the tube was opened, there exhaled a strong odour of hydrocyanate of ammonia, and the slip of paper, when dipped into a feeble acid, took a very intense blue colour.

As to the white sublimate, it had neither smell nor taste; it was insoluble in water; placed on burning coals, it was reduced into smoke. having the odour of hydrocyanic acid. Its minute quantity did not permit a more detailed examination, but M. Vauquelin thinks it is of the same nature as the crystals, *minus* the humidity.

What is then the composition of these crystals? This question is not easily answered, especially when one has at his disposal only a very small quantity of material.

However, if we bear in mind that cyanogen formed of carbon and azote, when decomposed in water, gives birth to hydrocyanic acid, ammonia, carbonic acid, and charcoal, which precipitates; and that in the case under consideration, the same effects take place, with the exception of the precipitation of carbon, it will appear undoubtedly probable, that this carbon is united with a portion of the undecomposed cyanogen, and that it is thereby rendered insoluble; but in falling down slowly it has had time to combine with a small quantity of water, and to assume the crystalline form; effects due to the low temperature in which the cyanogen was exposed during the winter. If this be the case, we might call this substance *sub-cyanogen* or *proto-cyanogen.*

We consider this nomenclature highly objectionable, admitting the composition to be clearly made out, which it is not. Cyanogen and sub-cyanogen should, strictly speaking, be called deuto-carburet and trito-carburet of azote; from which name their composition would immediately be seen.—*Ann. de Chim. et de Phys.* XXII. 132.

5. *Effects of Boracic Acid on the Acid Fluate of Potash.*

M. Zeise has made the observation that fluate of potash, in which the acid was in excess, might be rendered alkaline, by a suitable addition of boracic acid. The first portion of acid added diminishes the acidity, the following additions make it disappear entirely, for litmus paper is no longer changed by it; and lastly, the saline solution took an alkaline character, and restored to the blue colour, litmus paper which had been reddened by the acid fluate of potash.

A solution of litmus reddened by the boracic acid, was mixed with another solution of litmus reddened by the acid fluate, and instantly a blue colour was developed; the same effects take place by substituting soda or ammonia for potash; and it is the same whether we employ water or alcohol to dissolve them.

Syrup of violets, reddened by the acid fluate of potash, became blue by the addition of boracic acid, and a new quantity of acid rendered it green. Papers, stained with curcuma (turmeric) and Brazil wood, experienced analogous changes of colour; so that all the re-agents seem to indicate that alkali is separated from the acid fluate of potash by the addition of boracic acid; or otherwise, that the fluoboric acid, which may be formed by means of the fluoric and boracic acids, saturates less alkali, than each of its components would neutralize alone.—*Ann. de Chim. et de Phys.* XXI. 22.

6. *On the Hydroxanthic Acid, and some of its Products and Combinations. By* Mr. Will. C. Zeise, *Professor of Chemistry in the University of Copenhagen.*

By a series of experiments on the mutual action of carburet of sulphur, potash, and alcohol, Mr. Zeise has obtained results which he regards as very remarkable.

Potash, or soda, dissolved in alcohol, may be neutralized by carburet of sulphur, although this liquid does not change litmus colour, and does not neutralize the alkalis in their dry state, or when dissolved in water. This phenomenon is owing to the formation of a peculiar acid, by the re-action of the carburet on the alcohol, which is determined by the alkaline body. This new acid contains sulphur, carbon, and hydrogen. It is probable that the first two elements united act in this combination the same part the cyanogen does in hydrocyanic acid; and that they exist in it, in a different proportion from what they do in the ordinary carburet of sulphur. He has given the name of *xanthogen* (derived from ξανϑος yellow and γενναω) to this compound radical, because it forms combinations of a yellow colour with some metals; and he has named the new acid, the *hydroxanthic*, because it is endowed with all the properties of a perfect acid.

Very pure carburet of sulphur dissolves readily in the alcoholic solution of potash, and there instantly results a greenish-yellow liquid. This is easily observed by employing a solution of potash made in the cold before it has begun to turn brown. If, after having added enough of carburet to neutralize the solution, we expose it to a temperature approaching to 0° C., it will not be long in yielding delicate crystals so abundantly, that we shall soon have a concrete mass. This dried quickly between folds of paper is the hydroxanthate of potash. It is also obtained by evaporation of the neutral liquid, *in vacuo*, along with sulphuric acid, or even by spontaneous evaporation; and also by precipitation by means of sulphuric ether.

The process which he has commonly employed for the preparation of the hydroxanthate of potash is briefly as follows:—He puts one part of very pure and well calcined potash into a glass bottle, having a ground stopper; he pours on it about 12 parts of alcohol, containing about 96 or 98 in volume of pure alcohol; he next digests the mixture at a temperature of about 20° or 24° C., agitating it very often for two or three hours, and then filters the solution. Immediately afterwards he adds very pure carburet of sulphur, till the liquor no longer reddens turmeric paper; in order to be sure of which he puts in a little carburet in excess, that is, till a portion of the liquid poured into water throws up some oily globules. He now pours the liquid into a glass capsule with upright sides. When we employ an ordinary capsule, by reason of its great tendency to climb, it rises in abundance above the edges of the vessel. The capsule is then put immediately under the receiver of an air-pump, and a partial vacuum is made. When it is judged that the excess of carburet of sulphur with a portion of alcohol has been removed, he introduces a vessel containing sulphuric acid, and sets the pump in full action. At the end of some time he withdraws the vessel with the sulphuric acid, and replaces it by another of the same, till there remains very little liquid in the vessel containing the salt. Then, some time after, adding a little pure sulphuric ether, he throws the mass on a filter; a little thereafter he presses it quickly between folds of paper, and finishes the desiccation under the air-pump receiver. In winter, or in case we have plenty of ice at our disposal, he thinks the preparation of this salt may be effected by simple refrigeration. Evaporation in the open air has this disadvantage, that a part of the salt commonly assumes a yellow colour, and then it yields a solution more or less milky. We must take care not to employ too concentrated a solution of potash in alcohol; otherwise we obtain almost immediately a congealed mass, and here it may happen that a trace of sulphuretted hydrogen shall be formed.

Hydroxanthate of Potash.—This salt crystallizes in needles; it is colourless and very brilliant; in the air, it becomes faintly yellowish; it has a peculiar smell; its taste, at first, extremely cooling, becomes sulphureous and pungent. It is extremely soluble in water, and yet it does not attract humidity from the air. When newly prepared it dissolves completely in alcohol, but less copiously than in water; sulphuric ether dissolves very little of it, and petroleum does not affect it. A solution of this salt becomes milky by contact of air, and at the same time slightly alkaline. Hence test-papers, which on leaving a solution of hydroxanthate indicated no free alkali, change colour in the space of some time in the air.

On pouring acetic muriatic, or sulphuric acid, even in a very concentrated state, on the hydroxanthate of potash, no effervescence takes place; but the latter two acids, diluted with four or five waters, separate from it a liquid which is heavier than water, and in aspect perfectly resembling an oil. This is the *hydroxanthic acid.*

Barytes water, muriate, or nitrate of barytes, muriate of lime, sulphate of magnesia and alum, form no precipitates in a watery solution of the hydroxanthate of potash; sulphate of zinc, nitrate or acetate of lead, deutochloride or deutocyanide of mercury, produce white precipitates. With sulphate, nitrate, or muriate of copper, it occasions a precipitate of a very beautiful yellow colour. Chloride of antimony, nitrate of bismuth, deutochloride of tin, protochloride of mercury, and nitrate of silver, form also with it precipitates, which are of a yellow colour.

The precipitates by nitrate of silver, or protochloride of mercury, pass speedily from yellow to black; we can obtain even immediately black precipitates with these re-agents, if we employ very concentrated solutions. The precipitate by sulphate of zinc becomes slightly greenish on exposure to air. The others do not change their colour either in air or water. None of them effervesces either with the sulphuric or muriatic acid.

A solution of hydroxanthate of potash, very neutral, enclosed in a vessel which screens it from the action of the air, may be heated during half an hour at a temperature of 60° C. without losing its characteristic properties. But, if before heating it, we have rendered it alkaline by an addition of potash, it will soon acquire the property of precipitating the salts of lead black.

If we gradually heat the hydroxanthate of potash enclosed in a small retort, communicating with a receiver, from which a tube passes into a mercurial bath, the following circumstances take place: Before the temperature is raised beyond 60° C. the salt appears to undergo no change; when heated more strongly, it yields oleaginous vapours, fuses with a strong effervescence, producing abundance of gas and vapours, and is transformed into a mass of a blood-red colour. The vapours soon condense into a liquid, which has the appearance of oil. The red matter hardly changes its colour on cooling. On exposing this substance to a higher temperature than that at which it was produced, it enters anew into an effervescing fusion, blackening at the same time, and giving rise to much oil and a little gas. But, at the end of some time, the frothing ceases; and finally the mass, quietly melted, produces neither oil nor gas, even at a temperature not far from that of a cherry-red. On allowing the mass then to cool, it divides itself into two portions, of which the lower is manifestly crystalline, of a black grey, and a lustre almost metallic; whilst the upper layer, of a nearly black colour, has no crystalline texture. If the fire be pushed so as to keep the mass red for some time, it will not furnish the crystallized part. The gaseous product appears to be of the same kind during the whole course of the decomposition; the same holds true of the oily matter. The first is distinguished by an extremely strong odour of onions or leeks; but, in other respects, it comports itself (at least in trials with contact of water) like a mixture of carbonic acid gas and sulphuretted hydrogen.

Xanthic Oil.—This liquid is limpid, and of a yellowish colour. Its odour (which resembles neither that of carburet of sulphur nor sulphuretted hydrogen) is very strong, and adheres strongly and for a long time, to every body which has been impregnated with it. Its taste is at once saccharine and pungent. Water appears to dissolve it in very small quantity; alcohol, when diluted even to a great degree, dissolves it in abundance. The alcoholic solution is disturbed by a certain quantity of water; but, if not too much loaded with oil, it becomes clear, on the addition of a greater quantity of water. Xanthic oil does not affect the colour of litmus or turmene; it acts in no manner on nitrate of lead; it does not cause a precipitate with muriate of copper. At the approach of a flaming body, it readily takes fire, burns with a bluish flame, and gives rise to much sulphureous acid, mingled undoubtedly with carbonic acid. Water is condensed on the sides of a bell-glass suspended over the flame.

The *red matter* is deliquescent; dissolves completely in water; the solution is at first reddish, but soon becomes yellowish-brown. It strongly reddens turmeric. Alcohol acts but slowly on this substance.

The watery solution of the red matter, recently made, precipitates the salts of lead red; but commonly the precipitate becomes soon black; the cupreous salts are precipitated of a black-brown*. It does not occasion a precipitate with the salts of barytes; but a solution of the nitrate of barytes is coloured yellow. It makes a lively effervescence with acids, giving rise to an odour of sulphuretted hydrogen mingled with that of carburet of sulphur,—and there are, at the same time, separated globules of an oleaginous liquid; but no precipitate of sulphur takes place. A slip of paper imbued with nitrate of lead, and then exposed to the gas disengaged by muriatic acid, is coloured partly black and partly red. When exposed to the air, the red matter passes a little towards yellow.

The *crystalline matter* speedily deliquesces, and it dissolves in water without leaving any residuum. The solution is of a very intense brown-black, so that, before diluting it to a certain degree, the liquid appears nearly opaque; it becomes turbid on contact of air; and sulphuretted hydrogen, as well as a little sulphur are disengaged from it by acids. The matter *treated with a red heat,* seems analogous to a mixture of sulphuret of potassium with charcoal.

Hydroxanthate of potash, thrown on a glass-plate, red hot, readily takes fire, and burns quietly with a bluish flame; but if we set fire to it at the point of the flame of a candle, it burns with much energy, emitting sparks extremely brilliant. This somewhat singular phenomenon is, probably, due to flocks of charcoal, formed and projected by a partial decomposition of the salt, when it is exposed to a very strong heat which penetrates into the interior of the mass.

M. Zeise has prepared hydroxanthates of soda and ammonia, with alcoholic solutions of these alkalis and carburet of sulphur; hydroxanthates of barytes and lime, with the carbonates of these bases and hydroxanthic acid. The hydroxanthate of lime may also be obtained, but with difficulty, in a state of purity, by decomposing a very concentrated alcoholic solution of hydroxanthate of potash, with an alcoholic solution of chloride of calcium. He thinks it probable that the greater part of the precipitates, produced by decomposing the metallic salts with hydroxanthate of potash, are combinations of xanthogen with the metal of the salt employed. The precipitate from copper is not attacked either by sulphuric or muriatic acid, whether concentrated or dilute; nitric acid, however, (specific gravity 1.32,) dissolves it easily, with a production of gas, and a substance which has the aspect of fat, at first coloured greenish-yellow, then whitish-yellow. The xanthide of lead is prepared with nitrate of lead and hydroxanthate of potash; it is white, and falls down in flocks. Xanthic oil is given out on exposing these two xanthides to heat in a retort.

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* The solution is in this respect very similar to that obtained, according to M. Berzelius, by digesting for a long time in the cold an aqueous solution of potash with carburet of sulphur; or by adding carburet of sulphur to a watery solution of hepar.—*Ann. de Ch. et de Phys.* xx. 243.

Hydroxanthic acid is liquid at common temperatures, and even under them; it has completely the appearance of a transparent colourless oil. Its specific gravity is greater than that of water. It does not combine with this liquid. On contact of air it is soon covered with a white opaque crust. When much divided among water, it is completely destroyed in a short time. Its smell is strong and peculiar. It has at first an acid taste, then a very strongly astringent and bitter one. It reddens powerfully litmus paper, but a portion of the red is not long in becoming yellowish-white. To obtain hydroxanthic acid we introduce the hydroxanthate of potash into a long and narrow glass; we pour into it sulphuric acid, diluted with four or five volumes of water, aiding the re-action by a gentle agitation; two or three minutes afterwards, we add to the milky mixture, at intervals of some seconds, from three to four volumes of water, so managing it that the new acid may collect into a single mass at the bottom of the vessel; then we add speedily fifty or sixty volumes of water. It remains now only to withdraw the water, and to pour on new portions as speedily as possible; to withdraw this, and so in succession, till the washings no longer affect a solution of barytes. Instead of sulphuric acid, we may equally make use of the muriatic.

Hydroxanthic acid dissolves very readily in a watery solution of potash, barytes, or ammonia; it expels carbonic acid from the carbonate of potash, giving birth to a salt which entirely resembles that obtained by neutralizing an alcoholic solution of potash with carburet of sulphur. With carbonate of ammonia it furnishes hydroxanthate of ammonia, with disengagement of carbonic acid. It decomposes, also, carbonate of barytes, forming hydroxanthate of barytes, which is very soluble in water and alcohol. The re-action is, in general, much more lively when the salifiable bases or their carbonates are introduced in the solid state, into hydroxanthic acid, covered with a little water, than when we employ their solutions, which is undoubtedly owing to the insolubility of the hydroxanthic acid in water. Black oxide of copper, yellow oxide of lead, red oxide of mercury, each, when introduced into the hydroxanthic acid, under water, are quickly converted into xanthides, which nowise differ from those procured by precipitation. With oxide of mercury the action is very lively.

Hydroxanthic acid takes fire in the air instantly, on the approach of a burning body, occasioning a strong odour of sulphurous acid. When exposed to heat, in a suitable vessel, it is decomposed at a temperature much below that of boiling water; and there appear to be formed carburet of sulphur, and an inflammable gas. No odour of onions, or of sulphurous acid, is manifested.

Iodine was employed for ascertaining whether this new acid contained hydrogen, and the results show that it does. When iodine is introduced into newly-prepared hydroxanthic acid, covered with water, there is manifested instantly a lively action; the iodine is set in motion on the surface of the acid, and is dissolved. The acid becomes in part opaque, and is coloured at first yellow, then brown,—so that we have soon at the bottom of the vessel an oleaginous liquid of a red-brown; but, after a little time, the colour begins to disappear, and, in the space of some minutes,) provided too much iodine has not been added,) there results a liquid, oily, opaque, and faintly yellow. The watery liquor, which floats over the oleaginous liquid, is almost colourless; it is more or less milky,—but, by means of a filter, we obtain it perfectly limpid. When tried by the proper tests, this liquor is found to be a solution of hydriodic acid. The oleaginous liquid which remains, when we have treated hydroxanthic acid with a sufficient quantity of iodine, no longer yields xanthide of copper, with a sulphate of this metal. Comparative trials were made with carburet of sulphur, iodine, and water; the iodine combines with the carburet, colouring it violet; but, as might be presumed, no trace of hydriodic acid is produced.—*Ann. de Chim. et de Phys.*, xxi. 160.

7. *On a very beautiful Green Colour. By* M. Henri Braconnot.

M. Noel, who has a fine manufacture of painted paper at Nancy, sent M. Braconnot a superb green colour, known in commerce for some years, in order that he might analyze it. A manufacturer of colours at Schweinfurt was said to possess the sole secret of its preparation, Of all the methods tried by M. Braconnot to obtain this colour, the following succeeded best:—He dissolved six parts of sulphate of copper in a small quantity of hot water; and, on the other hand, he boiled in water six parts of arsenious acid, with eight parts of the potash of commerce, till no more carbonic acid was expelled. He mingled, by degrees, this hot solution with the first, agitating constantly till the effervescence ceased; a dirty greenish-yellow precipitate fell in abundance. To this he added about three parts of acetic acid, (three parts of which saturated 0.45 of carbonate of lime,) or such a quantity as that there was a slight excess of it, perceptible to the smell after the mixture. The precipitate gradually diminished in size; and, at the end of some hours, there was deposited spontaneously at the bottom of the liquor (now colourless) a powder, somewhat crystalline, and of a fine green colour. He separated the supernatant liquid, which, by resting longer on the colour, might deposit oxide of arsenic, which would render it paler. He afterwards treated it with a large quantity of boiling water, to remove the last portions of arsenic, beyond what existed in combination. We must take care not to add to the solution of sulphate of copper an excess of arsenite of potash, because it would saturate, in mere waste, the acetic acid, which ought to be in slight excess in the mixture, without causing any very obvious effervescence in it. For this reason, it is proper, in general, to take a neutral arsenite of potash. It is true that a portion of the arsenious acid remains in the mother liquor; but this may be employed for the preparation of Scheele's green, commonly used for painted papers of an inferior quality. It appeared that, when M. Braconnot added to the mixture, before the fine green colour was pronounced, a small quantity of the latter ready formed, the production of it was more speedily promoted,—as a crystal, plunged in a saline solution, attracts the molecules similar to its own.

The process now described has been repeated on the great scale, and with some modifications, at the manufacture of M. Noel. An arsenite of potash was employed, which had been prepared with eight parts of oxide of arsenic instead of six. The liquors were concentrated. Some hours after the mixture, a pellicle, of a very rich green colour, formed at the surface. The whole being exposed to heat, a heavy powder fell down, which was washed with abundance of water, to free it from the excess of arsenious acid. The green thus obtained was magnificent; and several unprejudiced colourists judged it to be more powerful than that of Schweinfurt.—*Ann. de Chim. et de Phys.*, xxi. 53.

8. *On the Combinations of Chromic Acid with Potash.*
By M. F. Tassaert, *fils.*

This gentleman affirms that a solution of chromate of potash, whether neutral or alkaline, will not yield crystals of a neutral salt, which salt can exist only in solution; and that, in reality, the lemon-yellow salt, known in commerce under the name of the *neutral chromate of potash* is a subsalt, for repeated washings and crystallizations do not deprive it of the property of restoring the blue colour to reddened litmus paper. In attempting to form the neutral chromate, he found that, when he employed a solution of chromate containing nitre, even in small quantity, this could be easily separated by adding to the liquors an excess of alkali. On subsequent concentration, the whole of the nitre crystallized in well-formed prisms, carrying down with it but a small quantity of chromate; whilst if we saturate first of all the solution of chromate, so as to make it neutral, and afterwards evaporate, since the salt thus formed and the nitre have nearly the same degree of solubility, they fall down together in crystals, and can no longer be separated: but the contrary takes place when the neutral chromate is converted into a subsalt, it thus becomes much more soluble, and lets the nitre form first.

This difference of solubility between the acid chromate and the subchromate of potash, is very well marked; for if into a saturated or nearly saturated solution of alkaline chromate, we pour some drops of acid, there is immediately formed an abundant deposit of acid chromate. To free the salt completely from nitre, he recommends it to be deflagrated with charcoal in a crucible; and afterwards to be dissolved, filtered, and crystallized. M. Tassaert analyzed the chromates of potash, by drying them for several days in a temperature of from 50° to 60° C., precipitating their acid by acetate ot barytes, washing the barytic salt, and adding to the supernatant liquid, sulphuric acid in excess; evaporating and igniting the sulphate of potash. He thus found that the acid chromate, which is naturally formed in the neutral solution, is composed of

Chromic acid	67.40
Potash	32.60

while the alkaline salt consists of

Chromic acid	52.0
Potash	48.0

It is to be observed, that chromate of barytes begins to dissolve in water, the moment that we remove from it the whole of the acetate of barytes that it contains mixed with it: it then dissolves in sufficient quantity to colour yellow the filtered liquors. A single drop of acetate of barytes, mixed with the edulcorating water, stops the dissolving process, and renders the filtered liquid turbid. Water, with a little alcohol, equally prevents this solution.—*Ann. de Chim. et de Phys.*, xxii. 51.

9. *Analysis of different Limestones, by* M. P. Berzelius, *Ingénieur des Mines.*

After giving a table of analyses of French limestones, not fit for water-mortars, which is of too little interest in this kingdom for us to copy, he next presents us with the following table of analyses of hydraulic limestones.

		1.	2	3.	4.	5.	6.	7.	8.	9.	10.	11.
	Carbonate of lime	0.900	0.858	0.892	0.890	0.890	0.825	—	0.792	0.765	0.800	0.840
	——— magnesia	0.050	0.004	00.30	0.020	0.020	0.041	—	0.025	0.030	0.015	—
	——— iron	—	0.062	—	—	—	—	—	0.060	0.030	—	—
Clay	Silica	—	—	—	—	—	—	—	0.065	0.116	0.170	0.100
	Alumina	0.050	0.054	0.078	0.090	0.090	0.134	—	0.038	0.036	0.010	0.050
	Oxide of iron	—	—	—	—	—	—	—	—	—	—	0.010
	Charcoal	—	0.022	—	—	—	—	—	0.020	—	—	—
	Water	—	—	—	—	—	—	—	—	—	0.010	—
		1.000	1.000	1.000	1.000	1.000	1.000	—	1.000	0.992	1.005	1.000

The first five are called moderately hydraulic; the last six very hydraulic.

No. (1.) Limestone of Vougy (Loire,) between Roanne and and Chaulieu; sublamellar, yellowish, full of ammonites, and other shells. It gives a very good lime, which sets in water. (2.) Limestone of St. Germain, (Ain,) compact, of a deep grey, veined with white limestone, lamellar, and penetrated with gryphites. It is employed at Lyons, for water-works. (3.) Limestone of Chaunay, near Macon; compact, in fine grains, yellowish-white; it is of the secondary formation, and is employed in the fabrication of a lime, which is hydraulic. (4.) Limestone of Digna (Jura); compact, penetrated with plates of limestone, and having imbedded a great number of gryphites, of a very deep grey. It produces lime which takes a good hold, and may be considered as hydraulic. (5.) Limestone, which accompanies the preceding, and which enjoys the same properties; compact, in grains nearly earthy, of a bright grey colour. (6.) Secondary limestone of Nismes (Gard); compact, yellowish-grey; yields a hydraulic lime, which passes in the country for being of excellent quality. (7.) Lime of Lezoux, (Puy de Dôme,) fabricated from a marly fresh-water limestone. It is called excellent. It produces an abundant jelly, with acids. (8.) Compact limestone, the locality of which is unknown. It gives a very good hydraulic lime. (9.) Secondary limestone of Metz (Moselle); compact, in grains almost earthy, of a bluish grey, more or less deep. The lime which it produces is known to be hydraulic. (10.) Marly limestone of Senonches, near Dreux (Eure et Loire); compact, very tender, crushes between the fingers, absorbs water very readily. It forms a paste with this liquid, nearly like clay, but it does not fall into powder, when calcined. This lime is very celebrated, and is much employed at Paris. (11.) Mixture of four parts of the chalk of Meudon, and one part of the clay of Passy, in volume, which M. Saint-Leger employs to make artificial hydraulic lime, in the manufacture of it, established near the military school. The government uses at present only the lime of M. Saint-Leger, in the public buildings of Paris. An immense consumption of it was made last year, for the canal of St. Martin; it has been judged superior to the lime of Senonches, a superiority of which M. Berthier has convinced himself by experiments on the small scale. It is sold at the price of 60 francs the cubic metre.

M. Berthier enters into a pretty full account of the Roman cement of Parker and Wyatt of London. The following is his analysis of the English stone, from which, by a regulated calcination, and subsequent pulverization, it is formed:

Carbonate of lime		0.657
———	magnesia	0.005
———	iron	0.070
———	manganese	0.019
Clay	Silica	0.180
	Alumina	0.066
Water		0.013
		1.000

Lime produced by the above.

Lime	0.554
Magnesia	0.000
Clay	0.360
Oxide of iron	0.086
	1.000

The English stone is compact, of a very fine grain, hard, tough, capable of taking a fine polish, and of a grey-brown colour. Its specific gravity is 2.59. It is said to be got in tubercular masses, in marls. There is a similar stone at Boulogne. M. Berthier thinks, that with one part of common plastic clay, containing no sand, and two parts of chalk in bulk, which corresponds to one part of clay to 2½ parts of chalk in weight, a very good hydraulic lime could be made, which would set as speedily as the English. He acknowledges, however, that it is not probable we can obtain by mixtures, hydraulic limes which can acquire so great hardness and solidity as the natural mortar, because these qualities depend, not only on the composition of the substance, but also on its state of compactness. We can conceive, that the greater density a hydraulic lime possesses, which slakes without changing volume, the greater facility its particles will have to become aggregated, and the less shrinking will there be in its consolidation. Whatever, therefore, we may do, the artificial mixtures will be always lighter than the natural stones.

The following general inferences, which M. Berthier draws from some subsequent experiments, are important. A limestone which contains 6 *per cent.* of clay, affords a lime already perceptibly hydraulic; when the clay is present in the proportion of 15 to 20 *per cent.*, the lime is very hydraulic; finally, the lime sets instantly, and may be regarded as Roman cement, when the limestone contains from 25 to 30 in the 100 of clay. He considers the iron and manganese as useless towards the hydraulic effect. To appreciate the qualities of a limestone, relative to the kind of lime which it can furnish, it is sufficient to determine the quantity of alumina and magnesia which it affords.

10. *Observations on Mortars.*

In a mortar which owes its solidity to the adhesion of the lime to the *alloys*, (the substances mixed with the slaked lime,) there is evidently an advantage in multiplying as much as possible the surfaces of contact, and consequently in employing a pulverulent alloy; but, the mortar in that case requires a larger proportion of lime than when we take a granular alloy. On the other hand, the alloys with large grains do not afford mortars so solid as the pulverulent alloys, because there remain among the grains of the alloy spaces filled with pure lime, which do not present the same resistance to fracture as the parts occupied by the alloy. It thus appears evident, that to obtain with the smallest possible quantity of lime, mortars which shall possess the *maximum* of solidity, we must employ alloys which contain particles of different sizes and pulverulent parts, avoiding always the mixture of argillaceous substances, which can form a paste with water, and which of themselves possess no coherence. M. de Saint-Leger made last summer trials on the great scale, the results of which coincide perfectly with these views. He found, contrary to the common opinion, that the sand usually employed at Paris, gives a better mortar, when it is merely washed, than when the fine particles are separated by means of a sieve.

The pozzolanas, both artificial and natural, differ extremely in their composition; they resemble one another only in the power they possess of absorbing water without softening; a power due to their porosity. It is probable, therefore, when they act on lime in a peculiar manner different from other alloys, such as quartzose sand, pounded glass, *&c.*, it is to their porosity, as M. John imagines, that they owe this property. The important observation made by M. Vicat, that clay slightly baked is an excellent alloy, whilst the same substance strongly calcined is a very indifferent one, supports the same opinion; for clay slightly baked, and that strongly calcined, differ from each other only in this, that the first is light, porous, and capable of absorbing water, whereas the last has become compact and altogether similar to a stone, by the effect of its contraction, which the high temperature has caused it to undergo. In other respects they are both in quite another state from raw clay, since they do not contain combined water, and can no longer form a paste with this liquid.

It is known that porous bodies have the faculty of absorbing and condensing rapidly a great number of gaseous substances. May it not be, because they act in this manner on the carbonic acid contained in the atmosphere and in water, that they have the property of accelerating the condensation of certain mortars? We may thus conceive why they produce this effect with a rich lime, whilst with poor or very hydraulic limes, they give no better result, than non-porous alloys; for, the mortars of rich limes owe their solidification only to the regeneration of carbonate of lime, while the solidification of the mortars of very hydraulic limes is independent of this cause.

To the above remarks we may add, that the English stone, from which Roman cement is made, is a ferruginous marl, in spheroidical concretions, called *septaria* or ludi Helmontii; a description of which is to be found in our common chemical works.—*Ann. des Mines.*

11. *Analytical Examination of Touch-stone. By* M. Vauquelin.

This stone, *lapis lydius*, is usually arranged in the works on mineralogy, in the sequel of the Cornéennes stones, without being entirely confounded with them. (It is the schistous jasper of Brogniart, and a sub-species of rhomboidal quartz of Mohs.) The specific gravity of the touch-stone of M. Vauquelin is 2.465. It whitens before the blow-pipe, exhaling a feeble sulphurous acid odour. The fragments which before calcination are crushed on glass, afterwards scratch it easily. It has no action on the magnetic needle. Acids in the cold exercise no perceptible action on a mass of touch-stone; but, if we heat muriatic acid on the mineral reduced to a fine powder, there is instantly disengaged a very manifest odour of sulphuretted hydrogen; a little iron is dissolved, and the acid becomes yellow. The residuum, which is considerable, seems to have become blacker by this operation.

The alkalis easily dissever the principles of touch-stone. With potash the fusion, at a red heat, is easy and very liquid, like that of siliceous stones. The mass becomes of a greyish-yellow. M. Vauquelin satisfied himself by means of ignition with chlorate of potash, that the black colour is owing to carbon; the quantity of which he determined from the volume of resulting carbonic acid. From the smell evolved by the action of potash on the mineral, he infers the presence of a small quantity of ammonia in it; which seems to be in the state of a muriate. He could not estimate its amount. The presence of sal-ammoniac, charcoal, iron, and sulphur, says

M. Vauquelin, may put geologists in the way of imagining the origin and mode of formation of this singular mineral production. The discovery of a quantity of this stone, of good quality, would be of great importance, adds he, to the goldsmiths; for it is rare, and extremely high priced.

Analysis.	First Specimen.	Second Specimen.
Silica	85.00	69.00
Alumina	2.00	7.50
Lime	1.00	a trace ——
Charcoal	2.70	3.80
Sulphur	0.60	a trace ——
Metallic iron . . .	1.70	17.00
Moisture	2.50	97.30
Loss	4.50	
	100.00	

Ann. de Chim. et de Phys. xxi. 317.

12. *Examination of an Aërolite which fell in the neighbourhood of Epinal on the* 13*th Sept.* 1822, *at the entrance of the forest of Taunière, three quarters of a league from la Baffe (Vosges.) By* M. Vauquelin.

This stone is in appearance like the ordinary aërolites; but is distinguished by the great quantity of metallic iron, and the small quantity of sulphur that it contains. By acting on its powder, with muriatic acid, and transmitting the evolved gas, through solution of acetate of lead, slightly acid, he had a precipitate of sulphuret of lead; from whose quantity he inferred that of the sulphur present. What was insoluble in muriatic acid, he washed on a filter, and afterwards calcined with caustic potash. The fused matter assumed a greenish tint. The muriatic solution was treated with gaseous chlorine, to peroxidize the iron, which was then thrown down with ammonia. From this precipitate, he separated the manganese and the minute quantity of magnesia, which might fall along with it by sulphuric acid. The following are the results on four grammes:

		In 100 parts.
Silica	1.40	35.00
Oxide of iron	2.51	62.75
Sulphur	0.09	2.25
Oxide of chromium .	0.01	0.25
——— nickel . . .	0.02	0.50
Magnesia	0.17	4.25
Lime and potash . .	0.50	1.25
	4.70	106.25

The 2.51 parts of oxide of iron correspond to 1.76 of metal;

but the 0.09 of sulphur require 0.16 of metallic iron to form a proto-sulphuret; and if we deduct besides 0.18 for the 0.25 of oxide of iron, obtained from the chromate, there will remain 1.42 of metallic free iron, containing only the nickel and the manganese. Of the fall of the above aërolite, some account is given in this Journal. xiv. 448.—*Ann. de Chim. et de Phys.* xxi. 324.

CHEMISTRY OF ORGANIZED BODIES.

13. *Analysis of the Fruit of Areca Catechu. By* M. B. Morin, *Apothecary.*

The tree called areca catechu by Linnæus, grows abundantly in the Molucca isles, in Ceylon, and several other of the southern countries of Asia. Its constituents are; 1. Gallic acid; 2. A large quantity of tannin; 3. Acetate of ammonia; 4. A peculiar principle analogous to that found in the leguminous plants; 5. An insoluble red matter; 6. A fatty matter, composed of elaïne and stearine; 7. Volatile oil; 8. Gum; 9. Oxalate of lime; 10. Ligneous fibre; 11. Mineral salts; 12. Oxide of iron and silica. *Journ. de Pharm. Oct.* 1822. p. 455.

14. *On the Action of Flowers on Air, and on their Temperature. By* M. Theodore de Saussure.

The flowers, even of aquatic plants, do not develope themselves in *media* deprived of oxygen gas; they require for the support of their vegetation a greater proportion of this gas than the rest of the plant. The green parts are often so abundant in the leaves, that they can of themselves form the atmosphere necessary to their existence; but it is not so with the flowers.

Several among them, as the rose, preserve, it is true, their corolla for a shorter time in the air than in vacuo or in azotic gas; but, when we expect to withdraw them still fresh, they exale an unwholesome smell, their petals are corrupted, and we perceive that this apparent life concealed a real death, while the fall of the blossom in the air is only an effect and a proof of vegetation.

When we place a flower under a receiver full of air, and shut by mercury, it changes little or nothing the volume of the air, while oxygen is present. It absorbs this gas, replacing it by a nearly equal volume of carbonic acid; *nearly*, because occasionally there is observed in the air, a slight diminution of volume, owing to porous absorption. M. de Saussure has not been able to find any trace of hydrogen in the air in which flowers have vegetated. His first trials made him imagine that they exhaled a small quantity of azote; but he has not confirmed this result. In estimating the quantity of oxygen destroyed by flowers, he weighs the latter, and takes their specific gravity as equal to that of water. The volume of oxygen consumed, is referred to the volume of flowers or leaves taken for unity. Thus the number 8.5, which expresses in the table, the quantity of oxygen gas destroyed by the *Tropæolum majus*, denotes that a cubic centimetre, or a gramme weight of these flowers (deducting the peduncles), destroyed 8½ cubic centimetres of oxygen gas, which were replaced by 8½ cubic centimetres of carbonic acid, in 200 cubic centimetres of air. The duration of the experiments, or the abode of the flowers and leaves under the receiver, was 24 hours. All the following results were obtained in summer, sheltered from the direct action of the sun, at a temperature between 18° and 25° cent. The quantity of oxygen destroyed by the flowers, is greater in the sun than in the shade; a rise of temperature also augments this destruction. He has inscribed on the table, the hour when the flowers were plucked, and placed (with their stalk in a very little water) under the receiver; this period is especially important for those which blow but a short time, and which expand only at a certain time of the day, as the *hibiscus speciosus*, *cucurbita melo-pepo*, and the *passiflora serratifolia*. Only flowers, entirely developed, and in perfect vigour, were submitted to experiment; characters which are recognized particularly by the *stamina*.

Names of the Flowers.	Oxygen gas consumed by the flowers.	Oxygen gas consumed by the leaves.
Single gilliflower (red) Cheiranthus incanus, 6 in the evening.	11.	4.
Double gilliflower, *idem.*	7.7	
Single tuberose (Polyanthes tuberosa) 9 A. M.	9.	3.
Double tuberose. *Idem.*	7.4	
Troæpolum majus (single) *idem.*	8.5	8.3
Double ditto. *idem.*	7.25	
Datura Arborea 10 A. M.	9.	5.
Passiflora serratifolia, 8 A. M.	18.5	8.5
Carrot, (umbels of) Daucus carota, 6 P. M.	8.8	7.5
Hibiscus speciosus, 7 A. M.	8.7	5.1
Hypericum Calycinum 8 A. M.	7.5	7.5
Cucurbita melo-pepo (male flowers) 7 A. M.	12.	6.7
Ditto. (female flowers,) *idem.*	3.5	
White lily, 11 A. M.	5.	2.5
Typha latifolia 9 A. M.	9.8	4.25
Fagus Castanea, 4 P. M.	9.1	8.1

The results here given indicate that in equal volume the flowers usually destroy more oxygen than the leaves in obscurity, or than the rest of the plant; for the leaves destroy much more than the stems and the greater part of fruits. The difference is more striking, and subject to fewer exceptions, as we shall show further on, if we consider in the flower merely the stamina. A single genus of flowers, that of the arum, has presented a phenomenon very worthy of attention, by a production of *heat* hitherto unknown.

15. *Examination of the Excrements of Serpents, exhibiting in Paris, of the Boa Species. By* M. Vauquelin.

His experiments prove, that the excrements are merely uric acid without any mixture, except a little ammonia, potash, and animal matter; and are consequently produced from the urine like that formerly discovered in the excrements of birds. But the true excrements of the serpents are not of the same nature as those now spoken of; for others were given him only of feathers slightly changed, and bones become very brittle and deprived almost entirely of their gelatine; which proves that feathers, that is the horny texture, is, of all animal matters, the most difficult to digest.

The first species of excrement issues from the body of the animal, in the form of a pap, resembling chalk or starch diffused in a little water. Sometimes they come forth in a concrete mass, like a calculus. This proves that the urine of serpents dwells, like that of birds, in a sort of reservoir, called *cloaca*, where it is inspissated.—*Ann. de Chim. et de Phys.* xxi. 440.

ART. XII. ANALYSIS OF SCIENTIFIC BOOKS.

I. *An Elementary Introduction to the Knowledge of Mineralogy; comprising some Account of the Characters and Elements of Minerals; Explanations of Terms in common use; Descriptions of Minerals, with Accounts of the Places and Circumstances in which they are found; and especially the Localities of British minerals. By* WILLIAM PHILLIPS, F. L. S., M. G. S., L. & C. &c. &c. &c. Third edition, enlarged.

THE third edition of this work has just made its appearance, and we congratulate the mineralogical public on the acquisition. The merits of the two former editions, (especially the second), have stamped a character on the book, that nothing we can say in its praise, can enhance, and have rendered its plan and contents so familiar to the cultivators of mineralogy, that it would be superfluous to attempt, in this place, a detailed account of them. Taking it for granted, therefore, that few mineralogists, who understand English, are unacquainted with the second edition, we shall proceed to show in what respects the present differs from its precursors, and point out the alterations, additions, and improvements, which its indefatigable author has introduced into it.

For this purpose, we shall begin by quoting some passages from the *Advertisement*, prefixed to this third edition.

> The most important additions and improvements that have been made, consist, first, in the introduction of notices or descriptions of about eighty minerals, of which the greater part have been discovered since the publication of the preceding edition; secondly, in the insertion of the results obtained by a careful examination of most crystalline minerals, as regards their structure and cleavage; thirdly, in the addition of a figure to the verbal description of most substances found in a crystallized state, representing the primary form, and another the secondary planes in connexion with those of the primary crystal, together with such measurements of the planes as I have been able to obtain, chiefly by means of the reflective goniometer of Dr. Wollaston; in the fourth place, advantage has been taken of a translation of Berzelius's excellent work on "The use of the Blowpipe in chemical analysis, and the examination of Minerals, by J. G. Children, F. R. S., L. and E., &c." in so far as relates to the more simple experiments with that useful assistant to the student, in recognising minerals; and, fifthly, the meanings of the names by which minerals are commonly known in this country, are mostly given at the foot of the page, containing the description, except where, being chemical, they manifestly have been derived from the composition of the substance.
>
> In regard to arrangement, no alteration has been made in this edition, except where new and more satisfactory analyses demanded a change: on the subject of the arrangement therefore, it seems requisite only to add that, having in the first instance adopted it, as being in my own estimation the most advantageous to the student that I could devise, the experience of its utility now induces me to recommend it to him as an instructive method of placing the minerals in his cabinet.

In this advice, we fully concur, and we believe that the mode of arrangement recommended by our author, has already obtained very general adoption. Since it is a consideration of primary importance, we shall briefly state its outline, as, notwithstanding our conviction that the work is in the hands of almost every mineralogist, there may be one or two unacquainted with it; and to such, if such there be, the statement *must* be useful.

The basis of the arrangement is chemical, and since certain substances are found to occur in very large proportion in those rocks which, geologically, are usually considered to be of the oldest formation, the close alliance between geology and mineralogy suggests the *order*, in which each class of minerals may be taken.

Some of the earths chiefly constitute those rocks which are esteemed to be of the oldest formation; while others do not enter into the composition of rocks, being found only in the veins which traverse them; these, therefore, (as veins are considered of posterior formation,) may be estimated as being of later origin than the former.

Of the alkalies and acids as mineral constituents, either combined with the earths or with each other, the former claim the precedence, as entering into the composition of the oldest rocks.

Two or three of the metals occur in small quantity in the masses of some of the earlier rocks; but in general the metals are found in veins; some in veins traversing the older rocks, and rarely or never in those of a newer kind; others most abundantly, or only in those of newer formation.

As rocks are constituted chiefly of earths, and metals are principally found in veins, earthy minerals may be assumed to be of earlier origin than the metalliferous.

Proceeding according to this assumed relation in the respective ages of the mineral elements, and beginning with the most simple, and ending with the most compound substance, our author places silica at the head of his list, "because it is estimated that silex forms the largest proportion of the oldest and most abundant of the primitive rocks; and all earthy minerals, of which silex is the largest ingredient, are arranged under that head; beginning, chemically, with silex in its purest forms, and proceeding to such as consist of that and another earth, as silex and alumine; then to those consisting of silex and lime, &c.; and afterwards to such minerals as are chiefly constituted of three or more earths, terminating with the most compound; and regarding the iron, manganese, &c., involved in many of them only as accidental ingredients;" because they do not alter the external form, and internal structure of those minerals.

The other earthly minerals are proceeded with in like manner; arbitrarily selecting such as contain the rare earth glucine, and placing them under that head, except that the gadolinite, which also contains the still more rare earth yttria, is placed under the latter.

Next after those minerals which consist only of one or more of the earths, succeed those in which one or other of the alkalies is found; to these, such of the acids as occur in the concrete state; then those minerals which are primarily constituted of one or more earths and an acid; and, after these, those consisting of an alkali and an acid; and, finally, the very few in which an earth, an alkali, and an acid are combined together.

Then follow those minerals (chiefly earthy) which have not been analyzed, or of which but little is known.

The native metals and metalliferous minerals succeed, arranged according to the order of age and formation; subordinately beginning with the metal in its native state, when it so occurs; then its combination with other metals, when in the state of a natural alloy; then combined with sulphur; with oxygen; and, finally, as an oxide combined with an acid.

The combustibles follow, beginning with sulphur, to which succeeds carbon in its purest form, and afterwards its several combinations with other bodies, as the base of the greater part of all the substances belonging to this class.

The order of arrangement is therefore as follows:—

Earthy minerals.
Alkalino-earthy minerals.
Acids.
Acidiferous earthy minerals.
Acidiferous alkaline minerals.
Acidiferous alkalino-earthy minerals.
Minerals (chiefly earthy) which have not been analyzed, or of which but little is known.
Native metals, and metalliferous minerals.
Combustibles.

In our opinion, this is at once the clearest and best arrangement hitherto suggested. Founded on the only rational basis, composition, it is so skilfully subdivided, that no confusion exists in any part of it. In point of convenience, too, in cases of hasty reference, the essential elements of any mineral are seen instantly by casting the eye on the running title at the top of the page, where its description occurs. It is hardly necessary to insist on the superiority of the preceding arrangement to that abominable violation of all chemical truth, which has placed crystallized carbon at the head of the earthy minerals!

With respect to the figures of the crystalline forms which accompany the descriptions, and which are neatly and accurately executed in outline on wood, Mr. Phillips informs us, that the measurements annexed to them are to be considered only as approximations to their true value, especially of the secondary planes; "for in no instance has it been attempted to correct the geometry of nature by a resort to the more rigid laws of calculation. It has been ascertained, by a comparison of the measurements taken from similar and brilliant planes of different crystals, that, owing to some natural inequality of surface, the same precise angle is rarely obtained, and hence those given in the succeeding pages cannot be expected to be absolutely exact." The error, however, rarely exceeds forty minutes, and is frequently not more than one or two minutes; and when the measurements of the primary form have been obtained from cleavage planes, (which is noted in the descriptions,) "they may be considered as approximating the truth much more nearly than when taken by means of the natural planes."

Where the regular solids, as the cube, regular octohedron, &c., are the primary forms, our author has adopted the measurements given by Haüy, and denotes them by the letter H annexed; but, where the primary form is not one of the regular geometrical solids, as the oblique, and doubly-oblique prisms, and the very numerous class of rhombic prisms, he has determined their true measurements by "subjecting the planes obtained by cleavage to the reflective goniometer—a more certain method than that adopted by Haüy;" who always, we believe, used the goniometer invented by Corangean.

> In regard to the figures to which the measurements are annexed, it may be observed, that these are not in all cases the representatives of single crystals, for in some of them are associated the planes observed on two or three: thus occasionally rendering the form more complicated than any single crystal I have seen, but not more so than may probably be found hereafter. This mode has been adopted as offering to the student the greatest assistance that I could devise, since it combines at one view all the observed planes, without increasing enormously the bulk, and consequent expense of the work, as must have been the case if all the varieties of form had been given separately.

We had some doubts, on first reading the preceding passage, whether this assembling of planes from different crystals into one sum total may not rather tend to perplex, than instruct the student. On further reflection, however, we are inclined to think our author is right, since a reference to the simpler forms, including the primary, of which a series of smaller figures generally accompanies the larger, will sufficiently elucidate the more complex, and, in some degree, imaginary, yet still possible, structure; and, in some instances, the planes on an actual crystal are so numerous, that nearly all that are represented on the large figures are discernible. Thus our author mentions a crystal of fluor, from Devonshire, in his own possession, which exhibits all the planes, except four, represented in the elaborate, and beautifully-distinct figure given at page 170, and would, if perfect, be bounded by 322 planes. If the figure we have just referred to was drawn by no "other rule than such as the hand and eye could furnish," as our author tells us the figures generally were, his hand and eye possess a skill and accuracy very seldom indeed to be met with.

In the useful introduction which precedes the mineralogical descriptions, not much alteration has been made in the present edition; the division which relates to analysis has been somewhat shortened, and, as well as the summary account of the elements of minerals, improved by a few judicious changes in point of arrangement, and in such other particulars as the progress of chemical science during the last four years has rendered necessary. The hypothetical wodanium is, of course, struck out altogether, and amongst the other essential alterations we are glad to see selenium removed from the list of metals, and restored to its more proper association with sulphur, phosphorus, and boron. Mr. Phillips remarks, both in this and the second edition, that we have no description of the iron pyrites from Fahlun, in which this substance is found. If it have any decided external characters, by which it may be distinguished, it is very desirable that they should be published, for we strongly suspect that many a specimen of common pyrites is sold as *seleniferous*, which does not contain an atom of selenium. We have ourselves witnessed, more than once, a lively competition for the purchase of such a specimen, said to be from

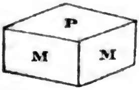
Fahlun, between two or three ardent collectors at an auction, till the price of the precious lot ran up enormously; whilst, from its perfect resemblance to some we had once an opportunity of examining, we felt confident, that it was quite guiltless of concealing a particle of selenium in its whole composition. The pyrites usually said to be seleniferous, is of a bright yellow colour, a small grain, and generally very friable.

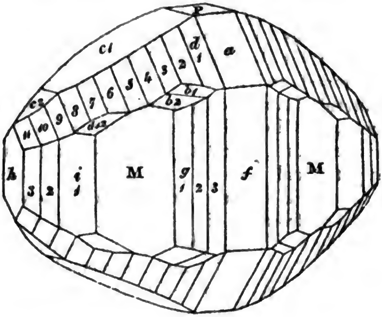
As a specimen of the elaborate figures which accompany many of the descriptions, we annex a copy of that which Mr. Phillips has given of Humite[*]. We have selected this mineral for our purpose, because,—1st., its form has never been described before. 2dly, Count Bournon, in his Catalogue, says that all its planes are striated, whereas not one of them is so; for what he mistook for striæ, are, in fact, so many planes, as has been proved by subjecting the crystals to the reflective goniometer. 3dly. It shews, therefore, the value of that instrument in a striking degree, and that the use of it quickens the sight of the observer, who, while measuring without a glass, finds planes, where an old, and generally supposed accurate, observer saw only striæ.

Humite.—*Bournon.*

It occurs in very small crystals, which are of a deep reddish-brown colour, and transparent or translucent, with a shining lustre. The crystals are modified in an extraordinary degree; their primary form may be considered as being a right rhombic prism, of 60° and 120°, but they yield to mechanical division, parallel only to its shorter diagonal: (*i. e.*, to the plane *h* of the following figure.)

Primary.





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[*] Humite. In honour of Sir Abraham Hume.

	°	′		°	′		°	′
M on M	120	00	*h* on *d* 4	119	24	*h* —— *i* 2	140	56
P on M or M	90	00	—— *d* 5	121	45	—— *i* 3	143	20
—— *f* or *h*	90	00	—— *d* 6	125	30	c 1 on *d* 1	155	2
M on *h*	120	00	—— *d* 7	129	46	—— *d* 5	159	10
—— *d* 1	118	12	—— *d* 8	121	20	—— *d* 7	159	30
or M or *f*	150	00	—— *d* 9	124	2	*d* 1 on *g* 3	116	25
P on C 1	144	1	—— *d* 10	136	16	*d* 12 on *d* 8	163	22
—— *c* 2	153	45	—— *d* 11	157	20	—— *g* 3	131	15
h on *a*	90	00	—— *g* 3	100	40	*b* 2 on *g* 3	143	15
—— *d* 1	101	50	—— *g* 2	103	40	*b* 1 on M	137	00
—— *d* 2	103	42	—— *g* 1	115	15	*f* on *a*	115	10
—— *d* 3	112	45	—— *i* 1	133	36			

It is found on Somma, with brownish mica.

The letters on each plane of the larger figure are placed according to the *system of notation* adopted by Mr. Brookes in his *Familiar Introduction to Crystallography*, of which we propose to give our readers an account in our next number. In the mean time we fully agree with Mr. Phillips in "recommending it strongly to the student, as being calculated to teach the interesting science on which it treats in its most pleasing form;" and we will add, as ably as pleasantly.

We should do our author injustice, if we were not to mention that the verbal description of the Humite is much shorter than the generality of the descriptions contained in the work. The hardness, specific gravity, chemical composition, and the principal characters of each substance before the blow-pipe, are, in most cases, carefully stated; and that they have been omitted in the description of Humite, is owing, we conclude, partly to its scarcity, and partly because it occurs only in minute, and, usually, separate crystals, wherefore the two first characters are hardly attainable, and we are not aware that any accurate analysis of this mineral has hitherto been made.

As only one plane of cleavage has yet been noticed, the primary form has necessarily been deduced from the nature and direction of the secondary planes, which, although perfectly consistent with the right rhombic prism, (the primary form adopted by Mr. Phillips,) are equally compatible with the assumption of a right rectangular prism for the primary form, in which case P, *f*, and *h*, would be the primary planes.

The utility of connecting the primary and secondary forms, as is done in a variety of instances throughout the work, is obvious; and a little attentive consideration will convince the observer of the manner in which the various secondary planes are allied to the primary crystal. Thus in the figure annexed, the planes *f* replace the *obtuse* lateral edges of the prism, and incline equally on M and M; the planes *h*, in like manner, replace the *acute* lateral edges;

the planes *a*, lying between *f* and P, replace the *obtuse* solid angles, while *c* 1 and *c* 2, lying between *h* and P, replace the *acute* solid angles. The planes *d* 1 to *d* 12 replace the *terminal edges* of the crystal, lying on the *acute* solid angles, in pairs, one of each pair being in the front, and the other on the back of the crystal. The planes *b* 1 and *b* 2 also lie in pairs, but on the *obtuse* solid angles, each pair being in sight, but only one of each is numbered. The planes *i* 1, 2, 3 are in pairs, replacing the *acute* lateral edges, one of each pair only being in sight; while the planes *g* 1, 2, 3 tend to replace the *obtuse* lateral edges, being also in pairs, visible in the figure on each side of the plane *f*.

The *getting-up* of the present edition is a considerable improvement on the second; the paper is much better, the type clearer, and the general appearance of the book neater and more elegant. The size of the work renders it a very convenient travelling companion, and the able manner in which a vast quantity of information is condensed into a small compass, makes it equally serviceable in the cabinet or the carriage.

II. *Traité Elémentaire des Réactifs, leurs Préparations, leurs Emplois spéciaux, et leurs Applications à l'Analyse. Par* MM. A. Payen, Manufacturier; *et* A. Chevallier. *Paris*, 1822. 8vo. Pp. 224.

If we except the fourth volume of Thenard's *Traité de Chimie*, there is no comprehensive system of rules delivered by modern writers for accomplishing these two great objects of chemistry—synthesis to effect analysis, and analysis to effect synthesis. Thenard is, however, excellent, in as far as he could be supposed to discuss so extensive a matter in 225 pages of rather open letter-press. He classifies under the six distinct heads of gases, combustible bodies, products of combustion, mineral salts, mineral waters, and vegetable and animal substances, the various subjects of analytical research; conveying judicious precepts for the elimination of the different constituents of a compound, and for ascertaining their proportions. In a short concluding chapter he describes the processes by which we may discover to what class of bodies, and consequently to what chapter of his instructions, any unknown substance is to be consigned. Of the estimation in which M. Thenard's system of analysis is held in this country, no better evidence need be adduced than the fact of two independent translations of it into English having been executed by very able hands. It is equally respected in France.

However valuable it may be, as a summary digest of analytical methods, its limits necessarily preclude many details of great interest and importance. We were, therefore, well pleased to observe the announcement of the work, whose title is prefixed to the present article. Its authors have been for some time active contributors to the *Journal de Pharmacie.* M. Payen, who is a manufacturer of sal ammoniac, lately wrote a good memoir on the discolouring properties of charcoal, to which the second prize was awarded by the Pharmaceutical Society of Paris. M. Chevallier published some time since an Analysis of the Mineral Waters of Pontivy; and the two gentlemen conjoined, inserted in the *Journal de Pharmacie* for September last, Experiments on the colouring matter of the Petals of the Malva Silvestris, and of the wood of St. Lucie (Cerasus Malaheb) employed as reagents, in which they sought to appreciate numerically their sensibility to alkalis and acids, compared with other coloured tests.

We were accordingly willing to expect, in a new treatise on chemical tests, published in the French capital, some novelty in the agents, or some ingenuity in their applications; something, in fact, to justify the appearance of such a work soon after the third edition of Thenard. But we are sorry to acknowledge that our expectations have been greatly disappointed.

MM. Payen and Chevallier have not, in reality, indicated any method of re-agency which is not better described in the Professor's treatise; while they seem to be unacquainted with many things which had been long ago effected in the same department by Bergman, whose treatise on the analysis of mineral waters, as far as his plan required, presents more minute and delicate rules of testing than we can find in the recent *Traité.*

The work is inscribed, in terms of merited respect, to M. Vauquelin, under whose superintendence they profess to have made their chemical studies. We wish they had consulted some of his excellent formulæ of analysis, from which they might have gleaned many ingenious tests.

In a short introduction they give a definition and description of the term re-agent, to which they subjoin the plan of the subsequent book. " Re-agents," they say, " are bodies which, placed in contact with others, give rise to new combinations; and which, during their re-action, produce peculiar and characteristic phenomena, which serve to make these bodies be recognised." Many things, however, which it would be difficult to bring under the above definition, are certainly re-agents; such as change of temperature, (or heat,) electricity, and magnetism. We would, therefore, say, that a chemical re-agent or test is a known body or power, which, being applied to an unknown substance, serves to point out, by characteristic phenomena, its nature or constituents.

Their work is divided into nine chapters. In the first they treat of the forms of bodies, of specific gravity, of the influence of bodies foreign to the combination, of the action of light and electricity. The second chapter discusses caloric, its action on different bodies, and the phenomena to which it gives rise. The third treats of the employment of simple combustible bodies non-metallic and metallic, and of the hydrated oxides. The fourth describes the combinations of simple combustibles with the metals. The fifth considers the bodies which result from the combination of acidifiable principles with hydrogen or oxygen; *viz.*, acids. To this chapter an appendix is subjoined, in which the combination of hydrogen with oxygen, and that of hydrogen with azote are discussed. Water and ammonia are here meant. The compounds resulting from the combination of the acids with the salifiable bases (salts), occupy the sixth chapter. The seventh is devoted to animal and vegetable products. In the eighth the manner of preparing and preserving the re-agents described in the preceding chapters is treated of; and the ninth contains some examples of the application of re-agents to analysis.

It is by no means our intention to follow the steps of our authors through their tedious common-places; nor shall we expend criticism on their vicious arrangement. We would rather use their work as the vehicle of communicating some practical remarks on the important subject which they have, without due preparation, taken in hand to discuss.

Analytical chemistry may be simply *qualitative*, or it may be likewise *quantitative*. To apply the former to an untried form of matter is an exercise of invention, and success in it is the prerogative of chemical genius. In this department, a mind guided by the routine of rules will be frequently at fault. To determine proportions is, perhaps, more irksome and laborious; but, for the most part, it requires much less ingenuity. Circumstances may occur, however, where the research of quantities may call forth no little invention. Two of the best examples to this purpose are to be found in Sir H. Davy's work on Nitrous Oxide and M. Gay-Lussac's Memoir on Prussic Acid.

Re-agents, as extemporaneous indicators, belong chiefly to qualitative analysis; but they may, without the use of the balance, by due care, throw considerable light also on quantity. This twofold application of tests was much considered by Bergman and Kirwan; but it has been almost wholly overlooked by MM. Payen and Chevallier.

To describe a chemical body is merely to detail its relations to other forms of matter, supposed to be previously known. An enumeration of these relations constitutes, therefore, the properties of the body. Hence a re-agent is a known substance, which, possessing some marked relation to another substance, serves, by its action with it, to ascertain its general and specific place in a chemical arrangement. In this extended sense the electroscope, common and voltaic, as well as the magnetic needle, and some optical instruments, deserve to be ranked among tests, though the term is usually restricted to chemical agents.

We conceive that the proper order of discussing the subject of chemical tests would be; first, to describe in succession the various substances entitled to this distinction, insisting particularly on the *criteria* of their purity; for the chief part of the mis-statements and contradictions to be found in chemical works, has been occasioned by the employment of impure re-agents. The details of their preparation should be referred to the ordinary systems of chemistry. After pointing out the means of verifying the justness of the tests, we should next detail their applications, stating fully the precautions to be observed in their use, and the peculiar phenomena which they produce with their correlative objects.

The second part of the treatise should present in a systematic, and, if possible, in a tabulated form, the various objects of chemical research, simple and compound, with their corresponding tests.

In the third, and concluding division, formulæ illustrated by examples, somewhat in detail, should be given, for evoking in succession the several constituents of a compound by the successive application of their appropriate re-agents.

Mess. Payen and Chevallier have incurred for their treatise the blame of confusion and tautology, by adopting a defective arrangement. In their second chapter we have an account of the action of heat on a long list of substances, placed in alphabetical order; which account would have been better introduced under the description of the various bodies in subsequent chapters. No use, however, is made of the indications of Berzelius. The rambling manner in which our authors sometimes indulge themselves, in trite details, may be judged of from the following specimen:

> Tin melts at 228° centig. At a much higher temperature it is reduced into vapour: when elevated to a red heat, if we throw it on the hearth it is divided into incandescent globules, which burn less vividly than those of antimony. It is distinguished, further, from this metal, because it leaves a greyish oxide, heavier than its oxide. Tin is susceptible by the action of heat of being totally oxidized, if we take care to remove the oxide in proportion as it forms on the surface of the metallic bath. By this oxidation the metal augments in weight. Brun, apothecary at Bergerac, is the first who took notice of this phenomenon; not knowing the cause of it, he consulted Jean Rey, physician, who replied, that "the air had become fixed in the metal." This bold reply should have put people in the way of seeing the composition of the atmospheric air. It was long afterwards, however, before its composition was discovered. P. 20.

What they are pleased to say of the blow-pipe is extremely vague, shewing that they were unacquainted with Berzelius's instructions for the use of this admirable test, a subject which they dismiss with a foot-note reference to his *Traitè sur le Chalumeau*. They speak indeed of the different intensities of heat in the different parts of the flame, but never hint at the opposite powers of oxidation and reduction which it possesses; the most important discovery ever made in the science of the blow-pipe.—*See our Extracts on this subject in* vol. xiii. p. 325, *of this Journal;* as also *Children's Berzelius*, pp. 29 and 49.

The third chapter is of great length. It treats of simple combustibles and their oxides. We shall take a cursory view of some of its particulars. We find chlorine recommended for demonstrating the presence and proportion of sulphuretted hydrogen, by the precipitation of sulphur which it occasions in this gas. But the sulphur will not be precipitated in an insulated form, provided enough of chlorine be present. A chloride is the result. Chlorine, when put in contact with carburetted hydrogen, is said to seize the hydrogen, and set the carbon free. But the formation of chloride of carbon renders the above test nugatory.

On turning to their eighth chapter, on the preparation and preservation of re-agents, we find it stated that 200 volumes of chlorine are soluble in 100 of water; and that this solution $=$ 24° on Baumé's hydrometer, corresponding to the specific gravity 1.2. This is a serious error. The above proportions reduced to weight are, 168 chlorine to 1 of water; so that were the total volume of the liquid to remain without increase, its specific gravity would be only 1.006. When the water of chlorine possesses this density or one greater, we may be sure that it is contaminated, probably with muriatic acid. They say that 133 parts of muriate of soda, with 110 of sulphuric acid, and 100 of oxide of manganese, should afford 80 of chlorine. But 133 parts of salt require for decomposition 106 of acid, leaving only four parts of acid, instead of 110, for saturating 100 parts of peroxide of manganese. Instead, therefore, of eighty parts of chlorine, from the above erroneous proportions, little more than forty will be obtained.

When hydrogen is disengaged from dilute sulphuric acid by the agency of zinc, it is properly enough directed to be passed through a solution of potash to deprive it of sulphuretted hydrogen. They take no notice of Berzelius's elegant application of hydrogen gas, as a test of oxygen in bodies; nor of a similar application of chlorine gas in the examination of certain ores.—*See this Journal*, xiii. 156; *and* xiv. 209.

Their process for procuring iodine is good for nothing; and when they prescribe a solution of this active body in alcohol to be kept as a test, they forget the production of hydriodic acid, which never fails to occur. The solution in alcohol should be, therefore, an extemporaneous prescription. That, or the watery solution, is a very delicate test of the presence of starch in plants, or in their products. A blue or purple colour is produced.

Bright silver is recommended as the test of sulphuretted hydrogen in mineral waters. They justly observe, in describing the process for obtaining the metal pure, that its precipitated chloride should be mixed with caustic potash, instead of the alkaline carbonate, which, during the ignition, is apt to scatter the particles of silver, and prevent them running together into a button at the bottom of the crucible. Tin affords the best criterion of a tungstate. When the metal is plunged into a solution of the salt, a blue precipitate falls, which has not been examined. Messrs. Payen and Chevallier prescribe, after Bergman, for the analysis of cast iron, to measure the bulk of hydrogen evolved during its solution in dilute sulphuric acid. They affirm that one gramme of iron should yield in this way 458 gramme measures of hydrogen, at 32° F. and

29.9 barom. pressure. By our calculation, one gramme of iron should afford only 424 gr. measures of hydrogen.

Pure zinc must be sought for by reducing to the metallic state the oxide thrown down from the purified sulphate. When this metal is employed to separate copper from its saline solutions, we must remember, that it precipitates this metal from the nitrate chiefly in the form of a subnitrate.

In the preparation of lime-water, we are rightly desired to reject the first portions of the solution, which may contain some saline matter. Lime-water is the usual test of corrosive sublimate; but hydriodate of zinc is much better. That water is also the common test of carbonic acid in an alkaline ley. We shall see presently that subacetate of lead is a far more delicate test. The chief employment of magnesia as a re-agent is in vegetable analysis, where it serves conveniently to precipitate the vegetable alkalis from their native combinations in the substance of plants.

Liquid potash is recommended for detecting the artificial coloration of wines. It affords, with these liquids, the following precipitates relative to the different colouring matters employed.

With the natural principle of wine the precipitate is	green
Berries of yeble	violet
Indian wood	violet-red
Mulberries	violet
Brazil wood	red
Beet	red
Turnsole or litmus	clear violet
Myrtle berries	wine-lees colour
Elder berries	bluish.

This test may possibly be applied with advantage to detect adulterations in much of the port wine retailed in this kingdom, which is a villanous compound of malt spirit and dye-stuffs.

A separate chapter is allotted to the deuto-chloride and deutocyanide of mercury, which bodies might have been better placed among the salts.

The acids used as re-agents are discussed in the fifth chapter. Strong acetic acid dissolves both gluten and resin. Dilution with water throws down the resin, and saturation with an alkali precipitates the gluten.

Arsenious acid is prescribed as a test of sulphuretted hydrogen; orpiment being formed by the combination. An arsenite is distinguishable from an arseniate by nitric acid, which throws down from a solution of the former arsenious acid in powder.

They free iron from cobalt by means of oxalic acid; the oxalate of the latter metal being insoluble.

Sulphite of lime is enjoined as a substance capable of arresting the fermentation of wines, and other vegetable juices.

A bar of zinc is said to answer for distinguishing the ammoniuret of copper from that of nickel. It precipitates the copper in the metallic state, whilst it occasions no change in the solution of pure nickel.

For separating nickel and cobalt, they adopt M. Laugier's process; who dissolves the oxalates of the two metals in water of ammonia. On exposing the solution to the air, the nickel precipitates, while the cobalt remains dissolved. Thus, it is said, a perfect separation can be effected. The details of this process were given some years ago in this Journal; but we have since found them practically exceptionable.

The sixth chapter treats of the principal salts, employed as re-agents. The application of acetate of lead, to estimate sulphuretted hydrogen, is one of the best chemical tests. The sulphates and carbonates should have been previously removed by nitrate of barytes. From the weight of the sulphuret of lead, the quantity of sulphur, amounting to $\frac{2}{15}$, may be computed; to which fraction, if we add $\frac{1}{16}$, the sum will denote the weight of the sulphuretted hydrogen. Another very general use of acetate of lead is, the separation of the acids from vegetable juices, or infusions. On exposing the saturnine salt to a current of sulphuretted hydrogen gas, the lead is converted into a sulphuret, and the vegetable acid remains free. By the same acetate, the tartaric acid is distinguished from the pyro-tartaric, the former yielding a precipitate of tartrate of lead; while the latter acid remains in solution. Acetate of lead is sometimes used as a test of sulphuric acid; but it is not very delicate. It will not detect $\frac{1}{10000}$, a quantity sensible to litmus infusion, or even pale litmus paper. Paper, imbued with acetate of lead, is a convenient test of sulphuretted hydrogen. Sub-acetate of lead is incomparably the nicest re-agent for detecting carbonic acid, or a carbonate, in solution. The same salt serves to separate picromel from the bile. For this purpose, we pour into that animal product, first, acetate of lead in excess. The whole of the yellow matter and the resin, fall down, in union with the oxide of lead. This oxide carries with it also, the phosphoric and sulphuric acids, which exist in the bile, in the state of phosphate and sulphate of soda. The liquor being filtered, and the precipitate washed, we pour into the clear solution sub-acetate of lead. The excess of oxide in this salt combines with the picromel, and is deposited with this substance, in the form of yellowish-white flocks. These being thrown on a filter, and repeatedly washed with water, are to be dissolved in dilute acetic acid, and the solution is to be exposed to a current of sulphuretted hydrogen. The lead falls down in the state of sulphuret. By evaporating the supernatant liquid, pure picromel is obtained.

MM. Payen and Chevallier mention a ready method of ascertaining the proportion of alcohol in wines, beer, cider, &c., long ago described by Mr. Brande, to 100 parts in volume of the liquid: to be tried, 12 parts of solution of sub-acetate of lead* are to be added; a precipitation ensues: which is rendered general by slight agitation. On filtering, a colourless fluid, containing the alcohol, is procured. By mixing with this dry carbonate of potash, (calcined pearl-ash,) as long as it is dissolved, we separate the water from the alcohol. The latter is seen floating above in a well-marked stratum; the quantity of which can be estimated at once, in a measure tube. Sub-acetate of lead is also employed for precipitating mucus in a flocky form, from its mixture with gelatine, which is not affected by the salt.

Borax, in coarse powder, or small lumps, is much employed by the French chemists, for separating muriatic and sulphurous acids from other gaseous bodies.

To detect lime in sugar, muriate of ammonia in powder is mixed with it, and heated. Pungent ammonia exhales. For the separation of alumina from its solution in an alkaline ley, sal ammoniac is the proper re-agent. A muriate of potash is formed; while the ammonia and alumina are both disengaged.

Under muriate of barytes, nothing is said, of the numerical power of this test of sulphuric acid. According to Kirwan, a solution of this salt produced a very sensible precipitation in water that contained only $\frac{1}{910256}$ of real sulphuric acid. Acetate of lead is ten times less sensible to this acid; while nitrate of lead, as well as nitrate and muriate of strontian, are far inferior tests. When the acid is combined with a base, as in sulphate of soda, the barytic salt is 11 times less sensible, even after two or three hours of re-action, than with the free acid. According to Bergman, solution of muriate of barytes *immediately* discovers about $\frac{1}{14625}$ of combined sulphuric acid, or $\frac{1}{81283}$ in two or three hours. The same test took twenty-four hours to detect one grain of sulphate of lime in 6000 of water.

Where boracic acid is suspected to be mixed with sulphuric, in a mineral water, muriate of strontian is a convenient re-agent, as it throws down the latter without affecting the former acid. In general, when muriate of barytes is applied to measure the amount of sulphuric acid, we should digest the precipitate in nitric acid of moderate strength; then wash, dry, and ignite. Thus the phosphate, borate, malate, tartrate, &c., will be removed.

Muriate of potash is prescribed for distinguishing tartaric from citric acid; for when it is added to a solution of the first, small brilliant crystals of bitartrate of potash fall; with the last acid, no change ensues.

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* This solution is made by boiling 15 parts of pulverized (and calcined) litharge, with 10 of acetate of lead, in 200 of water, for 20 minutes, and concentrating the liquid by slow evaporation to one half; it must be kept in well-corked phials, quite full.

Proto-muriate of tin converts the molybdic into the molybdous acid; and therefore occasions with it, and molybdate of potash, a characteristic blue precipitate.

Nitrate of silver is capable, according to Bergman, of detecting $\frac{1}{42250}$ of common salt in water; after standing some time, it would discover a much smaller quantity. According to M. Pfaff, proto-nitrate of mercury is a still more sensible test of muriatic acid. One part of muriatic acid, specific gravity 1.15 (equivalent to 0.283 of chlorine) diluted with 70.000 of water, is scarcely rendered feebly opalescent by the nitrate of silver; and when the dilution amounts to 80000, the effect is null. But the sensibility of proto-nitrate of mercury is such that even $\frac{1}{800000}$ of muriatic acid at 1.15, is indicated by a slightly chill shade in the water. MM. Payen and Chevallier maintain the superior delicacy of the silver test.

Proto-nitrate of mercury is said by Pfaff to be the most delicate re-agent for ammonia; one part of this alkali, diluted with 30000 of water, is indicated by a faint blackish-yellow shade, on adding the mercurial solution. Proto-nitrate of mercury may also be used for detecting phosphoric acid; the precipitate being redissoluble in nitric or phosphoric acid, which chloride of mercury is not.

Nitrate of silver serves to distinguish kinic from the other vegetable acids. The salts of the first acid do not disturb the transparency of the nitrates of silver, mercury, or lead. One grain of oxalic acid, according to Bergman, detects one grain of lime in 42250 of water. Oxalate of ammonia is, however, the suitable form of applying this test; MM. Payen and Chevallier say that it is sensible to $\frac{1}{25000}$ of lime.

In the seventh chapter of their treatise, where vegetables and animal re-agents are described, we find the following table of the solubility of some fixed oils in alcohol of specific gravity 0.817, at the temperature of 54°. 5 F.

Oil of sweet almonds	0.003
Beech mast . . .	0.004
Linseed	0.006
Hazel-nuts . . .	0.003
Common nuts . .	0.006
Olives	0.003
Poppies	0.004
Ditto, one year old .	0.008

In applying starch as a test of iodine, if the latter be combined with a base, we must liberate it by the addition of an acid, as the muriatic. After this, $\frac{1}{45000}$ of iodine may be rendered manifest by a violet or purple colour.

Animal charcoal deprives vegetable juices not only of their colour, but also removes the whole lime which they may contain;

a property of great consequence in the purification of beet-root sugar.

To distinguish a very small quantity of essential oil in a distilled water, a few drops of solution of muriate of gold are employed. The metal is reduced by the oil, and falls down in a violet powder.

On coloured tests for acidity and alkalinity, MM. Payen and Chevallier give us less definite information than we had expected. The alcoholic infusion of wild mallow petals, yields by evaporation, a colouring matter, which dissolved in water, is sensibly greened by a water containing $\frac{1}{200000}$ of hydrate of potash, or $\frac{1}{100000}$ of hydrate of soda. Lime water, with 10 additional waters, is the limit of dilution at which the mallow paper can be affected; but with 25 waters, the mallow infusion is still greened. Water boiled on calcined magnesia and then filtered, is capable of affecting the same test.

Litmus paper, according to Bergman, is sensible to $\frac{1}{3521}$ of free sulphuric acid in water; but not to a less proportion. The tincture or litmus is, however, much more sensible. When a drop of water impregnated with carbonic acid is applied to strongly dyed litmus paper, no change ensues, because the alkali of the litmus is adequate to the saturation of the minute quantity of that acid in a drop of the liquid; but the same water when poured into a weak infusion of litmus, reddens it perceptibly. In MM. Payen and Cevallier's paper on the wood of St. Lucie, it is stated that water containing $\frac{1}{8000}$ of sulphuric acid just reddens paper stained violet with an infusion of the fruit of that wood; but the infusion itself is sensible to acid diluted to $\frac{1}{200000}$. Litmus paper is said to be sensible to $\frac{1}{14000}$, and the tincture is a still more delicate test. Paper, stained red with infusion of Brazil wood, is an excellent re-agent for distinguishing several acids from one another.—See the extract of M. Bonsdorff's Memoir in this Journal XIV. 226. Paper stained yellow with turmeric is browned by water containing $\frac{1}{2217}$ of dry carbonate of soda; but it must be some time immersed in the liquid. This test is, however, of little use in determing alkalinity, since Mr. Faraday has shewn that it is liable to be browned by strong acids, as also by the boracic, by the green sulphate and muriate of iron, sub-muriate of zinc, supernitrate of bismuth, diluted chloride of antimony, of a strong solution of muriate of manganese, muriate, sulphate, acetate, and nitrate of uranium, and muriate of zirconia. See this Journal XIII. 315, XIV. 234. Rhubarb colour has similar fallacies. Mr. South shewed long ago, that subacetate of lead reddens turmeric.

Brazil wood is a pretty delicate test of alkalis; but it is blued by waters containing earthy carbonates, and sulphate of lime. Water holding in solution $\frac{1}{100000}$ of dry carbonate of soda, affects Brazil wood paper. Kirwan says, however, that it is not affected by water impregnated with $\frac{1}{500}$ of selenite. Reddened litmus paper is blued by water which contains $\frac{1}{2438}$ of dry carbonate of soda, according to Bergman. Infusion of red cabbage or of violets, and paper stained with their colours*, are also good tests, of acid and alkali; but less sensible than the preceding.

The ninth chapter of MM. Payen and Chevallier's work treats of the application of different re-agents to analysis; here we find little worthy of remark. Their instructions are neither so systematic nor so precise as those given by M. Thenard. The method of detecting magnesia, invented by Dr. Wollaston, and published long ago by his lamented friend, Dr. Marcet, in the second edition of *Saunders on Mineral Waters*, is briefly mentioned by our authors. The elegant manner in which the inventor practises this process on the smallest scale, having been somewhat vaguely described by M. Clement, in the *Annals de Chimie et de Physique*, for July, 1822, we shall take the liberty here of detailing it more precisely.

Dissolve in a watch-glass, at a gentle heat, a minute fragment of the mineral suspected to contain magnesia, dolomite for example, in a few drops of dilute muriatic acid; to this solution, add oxalic acid, to render the lime that may be present insoluble; then pour in a few drops of a solution of phosphate of ammonia †. Allow the precipitate to settle for a few seconds, and decant a drop or two of the supernatant clear liquid on a slip of window-glass; on mixing with this liquid two or three drops of a solution of the scentless carbonate of ammonia, an effervescence takes places; draw off to one side with a glass rod, a little of the clear solution, and trace across it, with the pressure of a point of glass or platina, any lines or letters on the glass plane; on exposing this to the gentlest possible heat (as making a little warm water flow over it), white traces will be perceived wherever the point was applied. These consist of the triple phosphate of ammonia and magnesia.

The whole of this beautiful analytical operation, as performed by Dr. Wollaston, occupies less time than we have taken to write the formula. In the application of this process on the larger scale, the carbonate of ammonia should be added first, which prevents the chance of any simple phosphate of the earth being formed. To estimate the quantity of magnesia present in any compound, we must consider, according to Dr. Marcet, every 100 grains of the triple salt dried at the temperature of 100° F. to be equivalent to 19 of earthy base. If we calcine the salt at a red heat, so as to expel all the water and ammonia, an earthy phosphate remains, which, according to Dr. Murray, contains 40 *per cent.* of magnesia. The theoretic proportions of the bi-phosphate of magnesia are 70 acid + 25 base, or 73.68 + 26.32 in 100 parts, and of the neutral phosphate 35 acid + 25 base, or $58\frac{1}{3} + 41\frac{2}{3}$ in 100 parts.

Nitrate of mercury has been lately prescribed as a test for examining sophisticated olive oil; it is prepared by dissolving in the cold 6 parts of mercury in $7\frac{1}{2}$ parts of nitric acid, specific gravity 1.36. This solution when added to oil of grains (as poppy seed oil) leaves it liquid, while it solidifies oil of olives.

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* The blue petals of the iris or water-flag, afford a good test colour either by infusion or by rubbing them on paper. Radish colour is transferred in the latter way, and forms a pretty delicate test paper.

† Phosphate of soda may likewise be used.

We have occasionally adverted in our Journal to the defective and confused notions entertained among the continental chemists about the atomic theory, which, in every useful point of view, is the offspring and growth of this island. The following paragraph, translated from this treatise on re-agents, affords a curious confirmation of our opinion.

> Dr. Wollaston, in the construction of the scale of equivalents, did *not* believe that he could make the numbers tally with the atomic theory; according to which, Mr. Dalton conceives that in the relative weights of the chemical equivalents, we estimate the united weights of a determinate number of atoms. Dr. Wollaston, moreover, did not see the utility of doing so for an instrument of application to practical purposes. However, we have learned, that since the publication of these synoptic rules, Dr. Wollaston has discovered that the doctrine of simple multiples (on which is founded the atomic theory), could be applied to the construction of his logarithmic scale, by simplifying all its relations; for if we assumed for unity, hydrogen instead of oxygen, all the results obtained till the present day would appear to confirm the first data; but, undoubtedly, they have not appeared sufficiently numerous to Dr. Wollaston, to induce him to generalize them. We expect, impatiently, the result of the important labour which this learned chemist has undertaken on this subject.—*Traité p.* 205.

Surely any man acquainted with the first elements of chemistry, who glances his eye over the scale, must see that the successive numbers, corresponding to the names, express the atomic weights or combining ratios of the different bodies, beginning with oxygen at the number 10. The French chemists, in general, have suffered themselves to be mystified on the principles of equivalent and multiple combination by the *Essay of Berzelius, on the Theory of Chemical Proportions;* a work which has done as much injury to the philosophy of the subject, as his precision in analytical research has improved its details. We recommend MM. Payen and Chevallier to read with attention the translation of Dr. Wollaston's Memoir on Chemical Equivalents, inserted by M. Descotils in the *Journal des Mines*, XXXVII. 101.

III. *Reliquiæ Diluvianæ; or, Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel; and on other geological Phenomena attesting the Action of an Universal Deluge.* By the Rev. WILLIAM BUCKLAND, B.D., F.R.S., *&c.*

THERE are few persons in whom zeal for the progress of a particular branch of natural knowledge is united to the same extent with capacity for the pursuit, as in Professor Buckland; he has taken up a very interesting branch of geology, and has investigated it with no less activity than success, and his researches have conducted him, by the legitimate steps of inductive reasoning, to some very important facts connected with the remote history of the earth. The existence of the bones of a great variety of animals, in some cases of extinct genera, and almost always of extinct species, in the superficial clay and gravel of valleys, and in certain caverns, has long excited the attention of geologists, but they have never been so perspicuously and popularly described as in the work before us; nor have the phenomena which attend their deposition, been so plausibly and philosophically accounted for by any antecedent writer. The fact is, that Mr. Buckland has in almost all cases judged for himself; he has personally visited the spots he describes, perambulated the caverns, exhumated their fossil remains, and inspected their various analogies and associations; instead of viewing the subject through the spectacles of books, and framing hypotheses by the fire-side, we find him busily journeying over a great part of Europe, for the express purpose of collecting information upon the subjects before us, and his success has been adequate to the labour bestowed upon the inquiry; for he has, in our opinion, not merely described, with much accuracy and minuteness of detail, the various districts which he has visited, a task in itself of no small importance and interest; but he has established several important facts in relation to geological theory, upon sound, firm, and indisputable evidence. Such are the leading features and prominent merits of Mr. Buckland's book; but it has other claims, which, in the capacity of reviewers, we think it right to notice, though they are of secondary and inferior consideration: we allude to the variety of collateral information scattered through its pages, connected with the habits of the animals, and to the relief which is given to the dry details by interspersed anecdotes and appropriate quotations; all this renders a work which, in the hands of a German professor, for instance, would have proved insufferably dull and monotonous, not merely very readable, but very interesting and entertaining, without in the smallest degree detracting from its scientific value or literary merit.

It would seem, from the table of contents, that Mr. Buckland's work is intended to be divided into two parts, the first containing an account of the localities and contents of various caves in England and Germany, with some observations on the osseous brecciæ of Gibraltar, Nice, Dalmatia, &c.; and the second embracing "the evidences of an inundation, afforded by phenomena on the earth's surface." In respect to the manner in which the work is got up, we need only say, that it is published by Mr. Murray.

The cave of Kirkdale, in Yorkshire, forms, as it ought, a leading subject of the volume: the rock which it perforates is that kind of calcareous freestone which constitutes the *oolite* formation, and which, from the circumstance of the ingulphment of several rivers that traverse the district, is probably abundant in caverns. It was discovered in the summer of 1821, by the quarrymen of the neighbourhood, who accidentally intersected its mouth, which was overgrown with bushes, and closed with rubbish, probably the debris of the softer portions of the circumjacent strata. But this original opening has been cut away, and its present entrance is a hole in the perpendicular face of the quarry, which expands and contracts irregularly, from two to seven feet in breadth, and from two to fourteen in height; the roof and floor are composed of regular horizontal strata of limestone, but in the interior the former is studded with stalactite, and the floor covered with a loamy sediment, of the average depth of about one foot, and concealing the actual floor of the cavern; the surface of this sediment was generally smooth and level.

Above this mud, on advancing some way into the cave, the roof and sides were found to be partially studded and cased over with a coating of stalactite, which was most abundant in those parts where the transverse fissures occur, but in small quantity where the rock is compact and devoid of fissures. Thus far it resembled the stalactite of ordinary caverns; but, on tracing it downwards to the surface of the mud, it was there found to turn off at right angles from the sides of the cave, and form above the mud a plate, or crust, shooting across like ice on the surface of water, or cream on a pan of milk. The thickness and quantity of this crust varied with that found on the roof and sides, being most abundant, and covering the mud entirely where there was much stalactite on the sides, and more scanty in those places where the roof or sides presented but little: in many parts it was totally wanting, both on the roof and surface of the mud and of the subjacent floor. Great portion of this crust had been destroyed in digging up the mud, to extract the bones, before my arrival; it still remained, however, projecting partially in some few places along the sides; and in one or two, where it was very thick, it formed, when I visited the cave a continuous bridge over the mud entirely across from one side to the other. In the outer portion of the cave, there was originally a mass of this kind, which had been accumulated so high as to obstruct the passage, so that a man could not enter till it had been dug away.

It deserves particular remark, that the mud and stalactite never alternate, but that there is simply a partial deposit of the latter on the floor beneath it, in which, and in the lower part of the earthy sediment, the animal remains were chiefly found. In the whole extent of the cave, very few large bones have been discovered that are tolerably perfect; most of them are fragmented, and some into very small pieces, cemented by stalagmite, so as to form an osseous breccia.

In some few places, where the mud was shallow, and the heaps of teeth and bones considerable, parts of the latter were elevated some inches above the surface of the mud and its stalagmitic crust; and the upper ends of the bones thus projecting, like the legs of pigeons through a pie-crust, into the void space above, have become thinly covered with stalagmitic drippings, whilst their lower extremities have no such incrustation, and have simply the mud adhering to them in which they had been imbedded; an horizontal crust of stalagmite, about an inch thick, crosses the middle of these bones, and retains them firmly in the position they occupied at the bottom of the cave.

The bones already discovered in the Kirkdale cave are referable to about twenty-three species of animals, namely, hyæna, tiger, bear, wolf, fox, weasel; elephant, rhinoceros, hippopotamus, horse; ox, and three species of deer; hare, rabbit, water rat, and mouse; raven, pigeon, lark, a small duck, and an unknown bird, about the size of a thrush. These were strewed all over the cave, like a dog-kennel, those of the larger animals, mingled with the rest, even in the inmost and smallest recesses; many of them gnawed, and the number of teeth and solid bones of the tarsus and carpus more than twenty times as great as could have been supplied by the individuals whose other bones are mixed with them. From the comminuted and apparently gnawed condition of the bones, Mr. Buckland remarks, that this cave was probably, during a long succession of years, inhabited as a den by hyænas, and that they dragged into its recesses the other animal bodies whose remains are found mixed with their own, a conjecture much strengthened by the discovery of the solid calcareous excrement of an animal that had fed on bones, which the keeper of Exeter 'Change at once recognised as resembling the recent fæces of the Cape hyæna. Mr. Buckland proceeds to verify this evidence, already very conclusive, by an inquiry into the habits of modern hyænas, of which three species only are known, and all smaller than the fossil one; they inhabit hot climates exclusively, and prowl about at night, clearing away the carcasses and skeletons left by vultures, in preference to attacking living creatures. They are so greedy of putrid flesh and bones, that they follow armies, and dig up bodies from the grave. They inhabit holes and chasms, are strong, fierce and voracious, and their eyes, like those of the rat and mouse, are adapted for nocturnal vision. To such animals the Kirkdale cave would certainly afford a convenient habitation, and the circumstances we find developed in it are consistent with these habits.

We must infer from the circumstance of the bones of the hyæna being as much broken up as those of the animals that formed their prey, that the carcasses of the hyænas themselves were eaten up by the survivors; and it is stated by Mr. Brown in his Journey to Darfu, that when a hyæna is wounded, his companions instantly tear him to pieces and devour him. But modern hyænas not only devour their own species, but upon a pinch they actually eat up parts of themselves. An old hyæna in the *Jardin du Roi* at Paris nibbled off his own hind feet, and the keeper of Mr. Wombwell's collection told Mr. Buckland that he had an hyæna some years ago which ate off his own fore paws. We, therefore, can want no further proof of the *voracity* of these animals. We insert the following passages as showing the minuteness and accuracy of Mr. Buckland's talent for investigation of this sort, and as bearing upon some important collateral parts of his inquiry.

> I have already stated, that the greatest number of teeth (those of the hyæna excepted) belong to the ruminating animals; from which it is to be inferred, that they formed the ordinary prey of the hyænas. I have, also, to add, that very few of the teeth of these animals bear marks of age; they seem to have perished by a violent death in the vigour of life. With respect to the horns of deer, that appear to have fallen off by necrosis, it is probable that the hyænas found them thus shed, and dragged them home for the purpose of gnawing them in their den; and, to animals so fond of bones, the spongy interior of horns of this kind would not be unacceptable. I found a fragment of stag's horn in so small a recess of the cave, that it never could have been introduced, unless singly, and after separation from the head: and near it was the molar tooth of an elephant. I have seen no remains of the horns of oxen, and perhaps there are none; for the bony portion of their interior, being of a porous spongy nature, would probably have been eaten by the hyænas,—whilst the outer case, being of a similar composition to hair and hoofs, would not long have escaped total decomposition.

The occurrence of birds' bones may be explained by the probability of the hyænas finding the birds dead, and taking them home, as usual, to eat in their den: and the fact, that four of the only six bones of birds I have seen from Kirkdale are those of the ulna, may have arisen from the position of the quill-feathers on it, and the small quantity of fleshy matter that exists on the outer extremity of the wings of birds,—the former affording an obstacle, and the latter no temptation, to the hyænas to devour them.

With respect to the bear and tiger, the remains of which are extremely rare, and of which the teeth that have been found indicate a magnitude equal to the great ursus spelæus of the caves of Germany, and of the largest Bengal tiger, it is more probable that the hyænas found their dead carcasses, and dragged them to the den, than that they were ever joint tenants of the same cavern. It is, however, obvious that they were all at the same time inhabitants of antediluvian Yorkshire.

As ruminating animals form the ordinary food of beasts of prey, it is not surprising they should abound in the Kirkdale Cave; but it is not so obvious by what means the bones and teeth of the elephant, rhinoceros, and hippopotamus were conveyed thither. Mr. B. suggests that these may perhaps be the remains of individuals that died a natural death; for though a hyæna would neither have had strength to kill a living elephant or rhinoceros, or to drag home the entire carcass of a dead one, yet he could carry away piecemeal, or acting conjointly with others, fragments of the most bulky animals that died in the course of nature, and thus introduce them to the inmost recesses of his den.

Should it be asked, why no entire skeleton has been found, we find a reply in the habit of the hyæna to devour the bones of his prey, and the gnawed fragments and *album græcum* afford evidence of such propensity having been gratified, though the latter is in much less quantity than we should have expected to find it; but from its want of aggregation when recent it would probably have been soon disintegrated and trodden down, except in particular instances of extreme constipation. The question which naturally suggests itself, why we do not find at least the entire skeleton of the one or more hyænas that died last, and left no survivors to devour them, is, we think, satisfactorily answered by our author, who ingeniously observes that the last individuals were probably destroyed by the diluvian waters, on the rise of which they may be supposed to have rushed out of their dens and fled for safety to the hills—that they were extirpated by this catastrophe is shown by the discovery of their bones in the diluvial gravel both of England and Germany.

Having thus summed up our author's evidence in favour of the Kirkdale Cave having been inhabited as a den by successive generations of hyænas, we shall not stop to consider the other hypotheses which may be suggested in reference to it; but proceed to some considerations which it suggests. In the first place, it appears manifest, that the accumulation of bones must have gone on through a long succession of years, *while the animals in question were natives of this country.* Secondly, the general dispersion of similar bones through the gravel of great part of the northern hemisphere, shows that the period in which they inhabited these regions immediately preceded the formation of this gravel, and that they perished by the same waters which produced it. Thirdly, that the bones belonged to extinct species which have never re-established themselves in the northern portions of the world. The phenomena of this cave, therefore, seem referable to a period immediately antecedent to the last inundation of the earth, when it was inhabited by land animals bearing a generic and often a specific resemblance to those which now exist; and they also seem to demonstrate that there was a long succession of years in which the elephant, rhinoceros, and hippopotamus had been the prey of the hyænas, which, like themselves, inhabited this country in a period immediately preceding the formation of the diluvial gravel. The catastrophe producing this gravel appears to have been the last event that has operated generally to modify the surface of the earth, and the few local and partial changes that have succeeded it, such as the formation of torrent gravel, terraces, peat bog, *&c.* all conspire to show that the period of their commencement was subsequent to that at which the diluvium was formed.

But we come now to one of the most curious parts of the very curious subject before us, which is, that four of the genera of animals whose bones are so widely dispersed over the temperate and polar regions of the northern hemisphere, at present exist in tropical climates only, and chiefly indeed south of the equator; and that the only country in which the elephant, rhinoceros, hippopotamus, and hyæna are now associated is southern Africa. In the neighbourhood of the Cape of Good Hope, they all live and die together, as they probably formerly did in Britain, whilst the hippopotamus is now confined exclusively to Africa, and the elephant, rhinoceros, and hyæna are also diffused widely over the continent of Asia.

As we consider it amply proved, by Mr. Buckland's researches, that the animals actually lived and died where their remains are now found, and were not drifted thither by diluvian torrents, it is pretty obvious either that the antediluvian climate of these latitudes was warmer, or that the animals had a constitution adapted to the regions of a northern winter. This last opinion derives support from the Siberian elephant's carcass discovered entire in the ice of Tungusia, the skin of which was covered by remarkably long hair and wool; and, in 1771, an equally remarkably hairy rhinoceros was found in the same country. There are, moreover, existing animals which have species adapted to the extremes both of polar and tropical climates. Though we confess ourselves rather inclined to adopt this view of the subject, it must be confessed that many stubborn facts may be urged against it, a few of which have been well put by Mr. Buckland, who espouses the former opinion. Such, for instance, as the abundance of vegetable remains, as well as those of animals, which are now peculiar to hot climates, but which abound in the secondary strata and diluvium of high northern latitudes. "To this argument," continues our author:—

To this argument I would add a still greater objection, arising from the difficulty of maintaining such animals as those we are considering amid the rigours of a polar winter; and this difficulty cannot be solved by supposing them to have migrated periodically, like the musk ox and rein-deer of Melville Island; for, in the case of crocodiles and tortoises, extensive emigration is almost impossible, and not less so to such an unwieldy animal as the hippopotamus when out of water. It is equally difficult to imagine that they could have passed their winters in lakes or rivers frozen up with ice; and though the elephant and rhinoceros, if clothed in wool, may have fed themselves on branches of trees and brushwood during the extreme severities of winter, still I see not how even these were to be obtained in the frozen regions of Siberia, which at present produce little more than moss and lichens, which, during great part of the year, are buried under impenetrable ice and snow; yet it is in those regions of extreme cold, on the utmost verge of the now habitable world, that the bones of elephants are found occasionally, crowded in heaps, along the shores of the icy sea from Archangel to Behring's Straits, forming whole islands composed of bones and mud at the mouth of the Lena, and encased in icebergs, from which they are melted out by the solar heat of their short summer, along the coast of Tungusia, in sufficient numbers to form an important article of commerce.

The chronological inferences deducible from the furniture of the Kirkdale den are summed up by Mr. Buckland at the conclusion of his description of it, and are briefly as follows: 1. There appears from the state of the sides and bottom of the cave, (beneath the bony aggregate,) to have been a period in which it existed as an untenanted and empty aperture. 2. It was inhabited by hyæna's, *&c.*; and, as we might suppose, stalactitic and stalagmitic formation still went on in it. 3. Mud was introduced, and the animal at the same time extirpated. 4. Stalagmite was again deposited, as shown by the crust upon the surface of the mud, and during this period no creature seems to have entered the cave, save and except rats, mice, rabbits, and foxes. From the limited quantity of the latter stalactite, and from the undecayed condition of the bones, our author argues that the time elapsed since the deluge is not of excessive length, that is, not exceeding six thousand years.

With the mass of minute and accurate information, derived from his visits to the cave at Kirkdale, Mr. Buckland proceeds to inspect several similar accumulations of bones in other parts of England; and having satisfied himself of their general concordance with the above, and of the verification which they afford of his main deductions, he determined upon a visit to some celebrated similar depositaries in Germany, of which the volume before us contains the most entertaining and instructive account extant. He shows from the history and contents of the diluvian gravel of the Continent, that it is identical with that of our own island; and that with respect to the bones that occur in caverns, the chief difference seems to be, that in Germany some of the caves have remained open, and have consequently been inhabited by modern or existing species. We cannot follow our indefatigable author into the details and descriptions of the interiors and contents of all these diluvian cemeteries, but the following remarks apply generally to them all:—

With respect to the apertures themselves, whether fissures or caverns, they appear to have been without mud or pebbles when the animals lived and died, whose remains are now found in them. In regard to the present mouths of these dens, our author adduces evidence to show, that they did not exist formerly as at present, but that they are rather truncated portions of the lower regions of the original caverns, laid open as it would seem by the diluvial waters which excavated the valleys in whose cliffs they stand, and which also drifted into these the mud and pebbles. The diluvial matter itself Mr. Buckland describes as either a mass of pebbles, or of loam, or sand, with bones indiscriminately distributed through them, and sometimes cemented into an osseous breccia by stalagmitic infiltrations; in short, there is a complete analogy between the caves of Germany and of England, not merely in respect to their earthy and osseous deposits, but in the species of the animals whose remains are enveloped in them.

The osseous breccia of Gibraltar, Nice, Dalmatia, *&c.*, comes next under our author's observation, and is ascribed to the same antediluvian period, with the exception of certain more recent deposits, of which some of our English caves and fissures also furnish instances, and which are ascribed to animals that have more lately fallen into them: when, however, the mouths of the fissures are closed, no such recent reliquiæ occur, and all is of a more ancient date.

The subject of human fossil remains is one of peculiar interest to the geologist, and particularly so in relation to the destruction of the human race by the deluge. But no human remains have yet been found associated with any of the unequivocal antediluvian inhabitants of the earth. Human bones, and even urns have been discovered in the caves of Gailenreuth and Zahnloch. In England, too, many human skeletons have been found in caverns, but always attended by circumstances which announce them of postdiluvian origin. Our author examined the remains of human bodies in the cave of Wokey Hole near Wells, and the following are his remarks upon them:

> They have been broken by repeated digging to small pieces; but the presence of numerous teeth establishes the fact that they are human. These teeth and fragments are dispersed through reddish mud and clay, and some of them united with it by stalagmite into a firm osseous breccia. Among the loose bones I found a small piece of a coarse sepulchral urn. The spot on which they lie is within reach of the highest floods of the adjacent river; and the mud in which they are buried is evidently fluviatile, and not diluvian; so also is great part, if not the whole, of the mud and sand in the adjacent large caverns, the bottoms of all which are filled with water to the height of many feet, by occasional land-floods, which must long ago have undermined and removed any diluvial deposits that may have originally been left in them. I could find no pebbles, nor traces of any other than the human bones, on the single spot I have just described; these are very old, but not antediluvian. In another cave on this same flank of the Mendips, at Compton Bishop, near Axbridge, Mr. Peter Fry, of Axbridge, discovered, in the year 1820, a number of bones of foxes, all lying together in the same spot, and brought away fifteen skulls. These, also, like the remains of foxes in Duncombe Park and near Paviland, are of postdiluvian origin, and were probably derived

from animals that retired to die there, as the antediluvian bears did in the caves of Germany.

In the neighbourhood of Swansea a number of human bones have also been found in a fissure of the limestone-rock; these are apparently the remains of bodies thrown in after a battle, and are not associated with any more ancient bones, or any appearances which connect them with antediluvian relics.

These and other instances of the existence of human bones, lead us to refer them to periods subsequent to those of the unequivocal diluvial deposits; indeed, the great abundance of the remains of wild animals in the latter lead us to believe that the countries could not have been inhabited by man; but that, on the contrary, the beasts must then have enjoyed sole dominion. Upon this subject our author agrees in opinion with Mr. Weaver.

That the satisfactory solution of the general problem, as far as it relates to man, is probably to be sought more particularly in the Asiatic regions, the cradle of the human race; and that another interesting branch of inquiry connected with it is, whether any fossil remains of elephant, rhinoceros, hippopotamus, and hyæna, exist in the diluvium of tropical climates; and if they do, whether they agree with the recent species of these genera, or with those extinct species, whose remains are dispersed so largely over the temperate and frigid zones of the northern hemisphere.'

Having thus illustrated his account of Kirkdale, and of the caves in England, by a comparative view of similar caverns and fissures on the Continent, our author proceeds in the second part of his book, to consider the evidence of diluvial action afforded by the accumulation on the earth's surface of loam and gravel, containing the remains of the same species of animals that we find in the caves and fissures, and by the form and structure of hills and valleys in all parts of the world. Of these remains, the bones of the fossil elephant are the most remarkable from their general and abundant dispersion; it differs from all living species of that genus, but approaches more closely to the Asiatic than to that of Africa; and, if we may judge from the Siberian specimen already adverted to, it was clothed with a coarse reddish wool, interspersed with stiff black hair, forming a long mane on its neck and back, and was at least 16 feet high.

It was to be expected that the remains of this gigantic animal should be found in the diluvial gravel of Yorkshire, from the fact already established, that these animals inhabited the neighbourhood of Kirkdale, whilst its caverns were occupied by the hyæna; and accordingly tusks and bones of elephants of enormous size have been found in the diluvium at Robin Hood's Bay, near Whitby; at Scarborough, Bridlington, and several other places along the shore of Holderness. Proceeding southwards we also find them in the interior of Suffolk, Norfolk, and Essex; and at Walton, near Harwich they are extremely abundant, blended with other diluvial bones. In the valley of the Thames they have been discovered at Sheppy, the Isle of Dogs, Lewisham, London, Brentford, Kew, Wallingford, Dorchester, Abingdon, and Oxford. On the south coast of England they occur at Lyme and Charmouth, and they have been found in the central counties. In North Wales, Scotland, and Ireland, these relics have also been met with always in the superficial gravel or loam, and never imbedded in what may be called the regular strata.

The circumstances that attend some of these deposits require to be more particularly detailed. In the streets of London, the teeth and bones are often found, in digging foundations and sewers, in the gravel *e. g.*, elephants' teeth have been found under twelve feet of gravel in Gray's-Inn Lane; and lately, at thirty feet deep, in digging the grand sewer, near Charles Street, on the east of Waterloo Place. At Kingsland, near Hoxton, in 1806, an entire elephant's skull was discovered, containing two tusks of enormous length, as well as the grinding-teeth: they have, also, been frequently found at Ilford, on the road from London to Harwich; and, indeed, in almost all the gravel-pits round London. The teeth are of all sizes, from the milk-teeth to those of the largest and most perfect growth; and some of them show all the intermediate and peculiar stages of change to which the teeth of modern elephants are subject. In the gravel-pits at Oxford and Abingdon, teeth and tusks, and various bones of the elephant, are found mixed with the bones of rhinoceros, horse, ox, hog, and several species of deer, often crowded together in the same pit, and seldom rolled or rubbed at the edges, although they have not been found united in entire skeletons.

For foreign localities of the fossil elephant our author refers to Cuvier's account of places in which they have been found all over Europe. Of these one of the most remarkable is in the valley of the Arno, near Florence, where they occur associated with parts of the skeletons of hippopotami rhinoceri, hyænas, bears, tigers, wolves, &c. In Asiatic Russia, from the Don to the extremity of the promontory of Tchutchis, there is not a river, in the banks of which they do not find elephants and other animals now strangers to that climate.

In treating of the evidence of the diluvial action afforded by deposits of loam and gravel, Professor Buckland very justly remarks, that the theories suggested to account for such appearances, have been defective from their attempting to refer to one circumstance two distinct classes of phenomena; namely, the general dispersion of gravel and loam over hills and elevated plains as well as valleys; and the partial collection of gravel at the foot of torrents, and of mud along the course and at the mouths of rivers. The former of these only appears to be the effect of an universal and transient deluge, whilst the latter are distinctly referable to the action of existing causes.

I have seen a good example of these two deposits in Holland in immediate contact with one another. The alluvial detritus of modern rivers, which is so enormous in that country, never rises above the level of the highest possible land-floods; but beneath this level forms nearly the entire surface of that low and extensive flat; whilst the diluvial deposits rise from beneath it into a chain of hills, composed of gravel, sand, and loam, which cross Guelderland, between the Yssel and the Rhine, from the south-east border of the Zuyder Zee, to Arnheim, and Nymegen, and form at the latter place a cliff, overhanging the left bank of the Waal, and another cliff of the same kind on the right bank of the Rhine, from Arnheim to Amerongen, on the road to Utrecht. In the districts that lie below the flood-level of these rivers, it is probable that there is an extensive deposit of this same diluvium buried beneath the alluvium, which forms the surface; and the certainty of this fact has been established in several places, where, from the bursting of dykes, the water has made excavations through the alluvium into the subjacent diluvium, and washed up form it the teeth and bones of the extinct elephant and other animals, which are peculiar to that formation.

We are sorry that we have neither space nor time for more extended quotations from this part of the work before us, which, though less captivating to the general reader than the history of the dens and their inhabitants, is, in a geological point of view, replete with important and essential data; and as we discover among the pebbles that constitute this diluvial gravel not merely the wreck of the adjacent inland districts, but also large blocks of primitive and transition rocks which do not occur in England, and which can only be accounted for by supposing them to have been drifted from the nearest continental strata of Norway, we must admit that a diluvial current from the north is the only adequate cause that can be proposed, and that satisfies the conditions of the problem.

In reference to this subject Mr. Buckland has given a summary of facts selected from various authorities, and from his own extensive observations, which tend satisfactorily to explain the great transportation of materials from one district to another at the period of the deluge, and which also elucidate the excavation of valleys, and develope the general causes of those minor irregularities which are engraved upon the earth's surface. The general shape of hills and valleys; the immense deposits of gravel and boulders, evidently immoveable by any streams now existing; the nature of these rounded fragments; the condition of the organic remains that accompany them, and the analogous occurrence of similar phenomena in all regions of the world hitherto investigated, are such decided and convincing proofs of the universality of the diluvial inundation, as must, independent of any other evidence, overrule all objections and difficulties connected with this very important subject. That there are difficulties to be removed, discordances to be cleared up, and doubts to be obviated, Mr. Buckland does not pretend to deny; but it is probable that these will, at length, be removed by the extension of observations, physical and geological, conducted upon the plan so ably laid down and successfully pursued in the work before us.

In conclusion, we shall only remind our author of the excellent advice and instructive observations of the President of the Royal Society, on presenting him with the Copley medal for his original description of the cave at Kirkdale, printed in the *Philosophical Transactions* for the year 1822. On that occasion Sir H. Davy took a luminous view of the importance and bearings of such researches, and suggested, in terms at once explicit and eloquent, the line of inquiry most likely to promote and perfect them; and the honours, thus conferred by the Royal Society, seem not to have been scattered upon barren ground, for to them we apparently owe the extended and minute description of the caves in Germany, contained in the present volume and the undiminished zeal with which Mr. Buckland is, as we are informed, at present pursuing his geological investigations.

To the Editor of the Journal of Science, &c.

SIR,

The candour and liberality by which your excellent Journal is so honourably distinguished, lead me to hope that you will admit a few observations, intended to remove an impression to the disadvantage of a highly respectable character.

In the review of " A Comparative Estimate of the Mineral and Mosaical Geologies," by Granville Penn, Esq., No. 29, page 112, is the following passage: " De Luc would not use the term *created*, ' because,' said he, ' in physics I ought not to employ expressions which are not thoroughly understood between men." Our author reprobates his conduct and his argument with just severity: " Was he aware," says Mr. Penn, " that in excluding the word, he at the same time excluded the idea associated with the word, and together with the idea, the principle involved in that idea; the exclusion of which is the very parent cause of all materialism and all atheism." The reader of this paragraph, if unacquainted with the writings and the character of Mr. De Luc, will certainly suppose that he did not believe, or at least thought it unphilosophical to acknowledge, that " in the beginning God created the heavens and the earth;" and the memory of one of the best and most pious of men may be injured by those who are ably defending the same cause which it was the business of his life, and the object of all his writings, to advocate. In the introductory chapter to " L'Histoire de la Terre et de l'Homme," Vol. 1, page 22, he says: " Je declare des l'entrée, que la consequence immediate de toute la partie physique de cet ouvrage est, que la Genése, le premier de nos livres sacrées, renferme la vrai histoire du monde; c'est a dire, que l'étude de la terre nous en montre les plus grands traits, et n'en contredit aucun."

Page 50. " Je suis convaincu de la certitude de la revelation et j'apporte ma petite contribution dans ses moyens de défense."—" J'entrepris d'observer le monde moral et physique; je lus ce qu'en disoient les philosophes, et bientôt je soupçonnai que ceux qui abandonnoient Moyse voyoient mal on raisonnoient sans examen."

After having, with the assistance of his brother, devoted thirty years to actual observation of the present state of the earth, Mr. De Luc says: " Lorsque nous fumes persuadés, par l'étude des phenoménes, que le recit de Moyse sur l'histoire de notre globe etoit le seul systême vrai, nous formames le dessein d'en instruire ceux qui ne recherchent pas."—Vol. 5. page 759.

The whole intention of De Luc's writings, during the course of a long life, is to confirm the Mosaic account of the creation and the deluge by accurate investigation of the present state of the globe. His system, with regard to the Deluge, is the same as that of Mr. Penn in his " Comparative Estimate, *&c.*;" and I believe that very able work would have met with his warm approbation. The only circumstance in which De Luc may appear to depart from the literal sense of the first chapter of Genesis, is with regard to the length of the period there called a day. Whether he was right or wrong in his ideas on that subject I do not presume to decide, but he certainly had no intention to deviate from the *meaning* of Moses, for every part of his work is written to support the authority of Scripture. Those who will take the trouble to look into his fifth volume, page 630, will find a clear account of his sentiments, which I should injure by attempting to curtail it. I could prove what I have here asserted from almost every page of his numerous publications, and particularly from his Letters to M. Le Tellier; but I will only beg leave to call your attention to the passage which you say Mr. Penn " reprobates with *just* severity." According to this gentleman's translation, De Luc says: ' I shall not say *created*, because in physics I ought not to employ expressions which are not thoroughly understood between men." The original is given in a note, and the words are, " Je ne dirai pas qu'elles ont été créés *ainsi*, parce-qu'en physique je ne dois pas employer des expressions sur lesquelles *on ne s'entend pas*."—Tom. 2. page 211. I request any person acquainted with the French language to compare the original with the translation, and they will see that the author has been misunderstood, and that his meaning is as follows: "I will not say that they have been created *thus*," (in their present state,) "because in physics I must not employ expressions on the sense of which people *are not agreed*." The whole passage runs thus. After describing two classes of mountains, he says of the second, "On les a nommées secondaires, et les autres primitives. J'adopterai la première de ces expressions, car c'est la même qui nous étoit venue à l'esprit, a mon frère et à moi, longtems avant que nous l'eussions vue employer; mais je substituerai celle de primordiales, à primitive, pour l'autre classe de montagnes, afin de ne rien décider sur leur origine. Il est des montagnes dont jusqu'à présent on n'a pu démêler la cause; voilà le fait. Je ne dirai dont pas qu'elle ont été créés ainsi, parce qu'en physique je ne dois pas employer des expressions sur lesquelles on ne s'entend pas. Sans doute cependant, que l'histoire naturelle, ni la physique, ne nous conduisent nullement à croire que notre globe ait existé de toute éternité, et lorsqu'il prit naissance il fallut bien que la matière qui la composa fut de quelque nature, on sous quelque premiere forme integrante. Rien donc n'empeche d'admettre que ces montagnes, qne je nommerai primordiales ne soyent réellement primitives; je penche même pour cette opinion."—Without pretending to any skill in geology, I appeal to the common sense of any person who can read and understand this quotation; and I ask whether the writer can be suspected of wishing to exclude the idea of creation?

If I express myself with warmth on this subject, I beg that I may not be supposed to speak with disrespect of Mr. Penn's admirable work, or to suspect the excellent author of intentional misrepresentation of a fellow-labourer in the same cause; but the character of a friend, whom I have respected and esteemed for more than forty years, is sacred in my eyes. Mr. De Luc was one of the best men and best christians that I have ever known, and I knew him *well*. Our late excellent king and queen honoured him with their esteem and confidence. Her majesty was his pupil during many years, and she would not have received instruction from a person whom she did not believe to be a *safe* guide on the important subjects of his lectures. He was sent by the king to Germany, to inquire into the state of religion there, and particularly into the views of the Illuminati, whose dangerous principles were first developed by him. It was De Luc who ventured to caution his royal master against the plausible, but dangerous, system of education, which it has since been found expedient to counteract, by establishing the national schools. On every occasion, M. De Luc was the active and indefatigable supporter of our constitution in church and state. His talents were always exerted in the cause of religion and morality, and his life exemplified every virtue which his writings are designed to inculcate. There may be mistakes in some parts of his system, but those who knew the *man*, as I had the happiness of knowing him, may venture to answer for the intentions of the *author;* of whom his opponent, M. Le Tellier, thus expresses *his* opinion: "Je vous réspecte comme grand Geologue, et comme ami et defenseur zélé du Christianisme."

We do not hesitate a moment to give the preceding communication, word for word, as we received it; and we are equally ready to express our full conviction that De Luc's *intentions* were as right-minded as our valued correspondent represents them to have been. We are not, however, so fully convinced, that, in the passage which has called for the preceding animadversions, he is not reprobated "with just severity." That Mr. Penn has not misunderstood it, for want of a sufficient knowledge of French, may be pretty confidently assumed by any one who has read his "Comparative Estimate," than which, we have met with very few works that evince a more perfect acquaintance both with modern and dead languages. Has he misrepresented it, then? We think not.—What can "des expressions" refer to, but the word *créés*, with or without its *ainsi*, as you please? It is the only word in the sentence about which any misunderstanding can by possibility exist. Had De Luc written, Je ne dirai pas qu'ils ont été *formés* ainsi, would he have thought it necessary to give his reason for declining the phrase? The question is, were the mountains originally formed as they now are, *créés ainsi?* or are they the result of a chymical crystallization from a chaos, or heaven knows what? De Luc would not undertake to say they were *created thus*, because it is an expression about which men are not agreed; that is, men are not agreed as to what is, and what is not, a *creation*, and *therefore* he declined to use the term. But whether Mr Penn (and we with him) has or has not misunderstood De Luc, we *are sure* that he has not *intentionally* done him injustice, (as indeed our correspondent admits;) and that the severity with which he felt it necessary in several instances, to comment on his writings, was painful to his own feelings. Witness the following passages, which we should have quoted in our late review of the "Comparative Estimate," had our space admitted of it. After another equally severe, and, in our opinion, equally just censure of De Luc's "daring and inerudite tampering with texts of Scripture," by which he interprets the six days of creation not to be "days of twenty-four hours, but periods of undetermined length," Mr. Penn adds, "It is not without sincere pain that I feel myself compelled thus strongly to censure this particular work * of the able and amiable De Luc; but in so sacred a cause, there may be no complimentary reservation from man to man. He has himself rendered it indispensably necessary that a strong and effectual caution should accompany his writings; because they tend to dissolve the foundations of the edifice, which they officiously offer to secure. They are calculated, therefore, to produce an evil which no hostile assault could effect; for they are calculated to attract a confidence, which an hostile demonstration would repel. De Luc designed friendship; but, unfortunately, the execution of his friendly design is real hostility. He was eminently distinguished, and his memory is deservedly honoured, in the department of *physics;* he was great, also, in shewing the concord of many *natural phænomena* with the Mosaic record of *the Deluge;* but there was the *limit* of his *true geology*. As soon as he attempted to proceed farther, and to argue *the mode* of the *first formation of this globe*, his mind lost its guide; he strayed *ultra crepidam*; and he brought himself into the same predicament with those whom he had before refuted and condemned in the article of *the Deluge*. The *measures of time* which he had philosophically denied to them, he now unphilosophically and inconsistently demanded for himself; *they* could not explain the *revolution* of this earthly system, without the aid of exorbitant measures of time which the Mosaical record refused them; and *he himself* could not understand the Mosaical description of the *creation* of this system, without exacting measures equally exorbitant, and equally refused by the record."—P. 208. "The general discernment and assertion of the great fact of *the Deluge*, was the bright point in his (De Luc's) geology. So long as his view was confined to the contemplation and exposition of that fact, his mind was collected and concentred †. When he quitted it, to put himself in search of *the mode* by which *secondary causes* produced *first formations*, it became perplexed and bewildered ‡. So long as he confined himself to the defence of that strong part, he evinced great skill, conduct, and resolution."—P. 273. "Thus much it has been indispensably necessary to expose as a cautionary distinction, and to insist upon, relative to this well-intentioned but dangerous instructor, lest his success in the *one argument* should become a snare to draw his readers into his own failure *in the other*."—P. 274.

We could quote many other passages in point, but it is unnecessary, We highly respect the feelings that have induced our correspondent to stand forward in defence of a man, at once eminent as a philosopher, and endeared by a long and ardent friendship. If we have joined with Mr. Penn in censuring some of his opinions, it is because we feel with him, that in so sacred a cause there may be "no complimentary reservation from man to man:" if those we entertain militate against the opinions of some other persons whom we highly honour, we may lament the discrepancy; but the same feeling forbids us to surrender our judgment, till *convinced* that it is erroneous. The sentiments we lately expressed, of Mr. Penn's "Comparative Estimate," we still retain, and shall continue to retain them till we see his arguments refuted by abler arguments, and his hypothesis subverted by one more consistent, *physically and morally*, with established facts, and the sacred record of the Bible.

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* *Lettres Géologiques.*

† *Lettres sur l'Histoire de la Terre.*

‡ *Lettres Geologiques.*

ART. XIII. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XIV.

i. *The Resistance of the Air, determined from* Captain KATER's *Experiments on the Pendulum.*

THE effect of resistances of various kinds on the vibrations of the pendulum is become a subject of increased importance. from its influence on the determination of a standard measure: for although the effect of these resistances on the time may be wholly inconsiderable, it is by no means superfluous to prove, by demonstrative evidence, that they are actually insensible.

A constant resistance, and a resistance proportional to the square of the velocity, produce either no change at all of the time of vibration, or an infinitely small change when the arc is infinitely small: but a resistance simply proportional to the velocity, if it be at all considerable, may produce a sensible retardation, even in an evanescent arc. It becomes, therefore, of some importance to inquire, what is the law of the resistance to very slow motions; and the elaborate experiments of the indefatigable Captain Kater will afford us the information that is required for establishing, in this respect, the sufficiency of the superstructure that has been built on them. It is, however, necessary, to take the mean of a large number of separate registers of observations, in order to investigate the laws of the retardation: for the question is so delicate, that the results of any small number of experiments might lead to very erroneous conclusions: but when properly analysed, the experiments, related in the third part of the *Philosophical Transactions* for 1819, are amply sufficient to show that a certain portion of the resistance to the motion varies simply as the velocity; and that it cannot be correctly expressed, as Mr. Gilbert has supposed, by a constant term and a term proportional to the square of the velocity only. Sir Isaac Newton, indeed, has hinted in the *Principia*, that a constant term, expressing the resistance derived from the thread suspending his pendulum, with another term proportional to the square of the velocity, might be sufficiently accurate for the purpose: and Euler has inferred, from Newton's experiments, that the constant resistance of the air to the motion of a leaden ball, two inches in diameter, was about one millionth part of its weight, or that it would cause it to remain at rest at an angular deviation of 0″.2 from the vertical line: but a part at least of this resistance may perhaps have been derived from the want of flexibility or elasticity of the thread.

From a mean of 60 experiments of Captain Kater, consisting of about 5000 vibrations each, we obtain 1.°185, 1°.086, 0°.997, 0°.919, and 0°.843 for the successive values of the arcs, at intervals of about 960 vibrations: and a slight irregularity in the second differences of these numbers makes it probable that .997 ought to be altered to .998. With this correction, the successive diminutions, in about 1920 vibrations, will be .187, .167, and .154, for the respective arcs of intermediate values, each of which must be supposed to exceed the intermediate arc actually observed by one third of its deficiency below the mean of the two neighbouring numbers, and we may call them 1.088, 1.000, and .9195, respectively.

Putting then $D = x + Ay + A^2z$, for the diminution of the arc, we have three equations, the last of which, subtracted from the first, gives us $.1685\ (y + 2.1075\ z) = .033$, and $y + 2.1075\ z = .1958$; consequently, if $z = 0$, $y = .196$, which would be the coefficient for a resistance simply proportional to the arc, giving $x + .196$ for the amount of the second diminution, that is, .167; so that x would require to be negative, which is impossible: and if $y = 0$, $z = .093$, and the second diminution would require x to be .074: a value which is sufficiently compatible with these equations, but which would not be applicable to the shorter vibrations; an arc of 0.°80, for example, exhibiting a diminution of about .11, and leaving only about .050 for x, so that x must probably be still smaller than .05, and if we make it $= .040$, we shall have .127 left for $y + z$, and $.196 - .127 = .069 = 1.1075\ z$, and $z = .062$, and $y = .065$, and $D = .040 + .065\ A + .062\ A^2$, which gives .132 for an arc of .8, and x is still too large. Now, if we take

x somewhat smaller, we shall reduce the expression to a perfect square, and we shall find that $(.16 + .25\,A)^2 = .0256 + .080\,A + .0625\,A^2$ will represent the diminution with great accuracy, giving .187, .168, and .152, for the respective arcs of 1.09, 1.00, and .92: and this expression has the advantage of affording a very easy integration for the arc.

For, if t be the number of vibrations divided by 1920, we have $-\,dA = (.16 + .25A)^2\,dt$, and $\dfrac{-dA}{(.16 + .25A)^2} = dt$: but $d\,\dfrac{1}{.16 + 25A} = \dfrac{-.25dA}{(.16+25A)^2}$, and $\dfrac{4}{.16 + .25A} = t + c$ or $.16 + .25\,A = \dfrac{4}{t+c}$, and $.64 + A = \dfrac{16}{t+c}$: whence, putting $.64 + A = B$, and its initial value b, $b = \dfrac{16}{c}$, and $c = \dfrac{16}{b}$; consequently $B = \dfrac{16}{\dfrac{16}{b} + t}$, and $\dfrac{1}{B} = \dfrac{1}{b} + \dfrac{t}{16}$.

In many of the series of experiments, it is necessary to make some variation in the constant coefficients, on account of the state of the atmosphere, and we may take in general $B = A + C$, and $\dfrac{1}{B} = \dfrac{1}{b} + \dfrac{t}{q}$, the factor q, in the case already computed, being made either 16, or 16 × 1920, accordingly as we wish to take the interval of the coincidences for the unit of time, or to express it in seconds; and C, in some of the series of experiments, appearing to be about 1° or even 2°, instead of 0°.64. The supposition of $C = 1°$ is equivalent to that of $D = .04 + .04\,A + .01\,A^2$, q becoming in this case 25.4 instead of 16. The constant part of D, expressed by x, causes in half a vibration a retardation of $\dfrac{1}{3840}\,x = 0°.000067 = 0'.004 = 0''.24$, which happens to agree singularly well with the 0.″20 deduced by Euler from Newton's experiments.

We may easily compute, from the value of A thus determined, the total retardation depending on the vibration in a circular curve, which is expressed, for a small arc of vibration, by one-eighth of the verse sine, the whole time of the vibration being unity, or, for the arc A, since the verse sine of 1° is .000152, by very nearly $.000019\,A^2$; and the fluxion of the time being dt, that of the circular excess will be as $A^2dt = (B - C)^2\,dt = C^2\,dt - 2BC\,dt + B^2\,dt$: now $\frac{b}{B} = 1 + \frac{b}{q}t$ or $= 1 + pt$, putting $p = \frac{b}{q}$, and $B = b\,\frac{1}{1 + pt}$, and $\int\frac{dt}{1 + pt} = \frac{1}{p}$ hl $(1 + pt)$, consequently the fluent of the second term is $-\,2C\,\frac{b}{p}\,\mathrm{hl}\,(1 + pt) = -\,2Cq\,\mathrm{hl}\,\frac{b}{B}$; that of the third, or $\frac{bb}{(1 + pt)^2}\,dt$, being, when corrected, $\frac{bb}{p}\cdot\frac{pt}{1 + pt} = b^2\frac{t}{1 + pt} = b^2t\,\frac{B}{b} = bBt$; so that the whole circular excess will become $.000019t\left(C^2 - 2C\,\frac{b}{pt}\,\mathrm{hl}\,(1 + pt) + \frac{bb}{1 + pt}\right)$ or $.000019t\,(-\,.41 - 1.28\,\frac{q}{t}\mathrm{hl}\,\frac{b}{B} + bB) = .00001\,(1.9bB - 2.432\,\frac{q}{t}\mathrm{hl}\frac{b}{B} + .779.)$ Taking for example, Captain Kater's first register of experiments, in which $a = 1°.38$, and A .92, when t was $\frac{5}{2}$, so that $\frac{b}{B}$ being $\frac{2.02}{1.56} = 1.2949 = 1 + \frac{b}{q}\,t = 1 + \frac{5.05}{q}$; we must here make $q = \frac{5.05}{.2949} = 17.124$, and $\frac{q}{t}$ 6.850, and hl $\frac{b}{B}$ being $= .7031 - .4447 = .2584$, the whole is $.00001\,(5.987 - 4.304 + .779)\,t = .00002462$, or 2.12 in 86050 vibrations; which agrees exactly with Captain Kater's computation from the separate arcs observed.

If we adopted the Newtonian hypothesis of a resistance measured by $m + n\,A^2$, we should have $\frac{-dA}{m + nA^2} = dt$, and $t = -\sqrt{\frac{1}{mn}}$ arc tang$\left(\sqrt{\frac{n}{m}}\,A\right)$, consequently $\sqrt{(mn)}\,t = -$ arc tang $\left(\sqrt{\frac{n}{m}}\,A\right)$, and tang $\sqrt{(mn)}t, = -\sqrt{\frac{n}{m}}\,A$ and $A = -\sqrt{\frac{m}{n}}$ tang $(\sqrt{(mn)}\;t) + c$; and, for the correction of the fluent, $a = +c$, and $A = a - \sqrt{\frac{m}{n}}$ tang. $(\sqrt{(mn)}t)$.

There appears to be an oversight in a remark inserted among the *Elementary Illustrations of the Celestial Mechanics*, p. 145; where it is observed that "the whole time of the oscillation can never be sensibly affected by any small resistance proportional to the velocity;" for, in fact, the coefficient γ, in the expression of Laplace, being equal to $\sqrt{\left(k - \frac{mm}{4}\right)}$, is in some degree affected by m, which expresses the resistance; and the time is affected by γ, though Laplace has not investigated the precise effects of a given resistance. That which is here inferred from Captain Kater's experiments, however, would scarcely produce a retardation of one fiftieth of a second in a year: and must, therefore, be wholly neglected.

If we are anxious to reconcile the existence of a retardation proportional to the velocity, with the common theory of the impulse of fluids, it will not be difficult to understand how the one may possibly be derived from the other. We have only to suppose the pendulum subjected to the influence of a very slow current of air, in order to deduce a resistance nearly proportional to the velocity v from another, which depends on $(c \mp v)^2$. For it will appear, by considering the directions of the forces concerned, that at the extremities of the vibration, while the velocity of the current exceeds that of the pendulum, and $c - v$ remains positive, the quantity $2cv$ will denote a retarding force throughout the motion, and that the portions c^2 and v^2 will be retarding in one direction and accelerating in the other, and will have no sensible effect on the extent of the vibrations;

while, on the other hand, if the velocity of the pendulum towards the middle of the vibration exceeds that of the current, the force $2cv$ will retard the motion in one direction, and accelerate it in the other, leaving only the constant resistance c^2, and the variable quantity v^2, which is proportional to the square of the velocity. We obtain, therefore, for the extremities of the vibrations, a force proportional to the simple velocity, and for the middle, a constant resistance, and another force varying simply as the velocity, the joint effect of all which must be a resistance nearly such as has been inferred from Captain Kater's experiments, if the current moved at the rate of about half an inch in a second, which would have been scarcely perceptible to the senses.

The question, however, regards not so much the distribution of the resistance through the different parts of a single vibration, as its comparative value for the mean velocities of the successive vibrations. Now, if the velocity of the current always exceeds that of the pendulum, the only effective resistance will be proportional to the simple velocity; and when it is smaller than the greatest velocity of the pendulum, the resistance will approach more and more to the ratio of the square of the velocities increased by a constant quantity; and supposing the velocity of the current to remain small and nearly uniform, while the arc of vibration considerably diminishes, the whole resistance will at first be more nearly as the square of the arc, and if the arc be sufficiently diminished, the resistance proportional to the simple velocity will at last remain alone. Hence, it is easy to understand the variation of the constant coefficients in the different series of Captain Kater's experiments.

12 *April*, 1823.

ii. *Extract from a Letter to* Professor SCHUMACHER, *relating to* BESSEL'S *Refractions.*

I do not quarrel with you for your confidence in Bessel: but I think you have not sufficiently attended to the limitation under which he himself originally published his Theory of Refraction, Fundam. p. 55. "*In distantiis à vertice* non superantibus 86°, *tabulæ meæ, ut docet allata comparatio, prorsus cum observationibus* Bradleianis *congruunt.*" And, in fact, the mean errors, as deduced from his own computations, p. 53, are these:

	°	′		″
Zenith Distance	89	28	Error	+ 37.0
	88	40		+ 10.7
	88	13		+ 11.1
	87	34		+ 4.0
	87	24		+ 2.7
	87	9		+ 4.7

We may also consider Mr. Delambre's authority as amply sufficient for the refraction at the horizon, which he makes 33′ 46″.3, from *several hundred* observations, made at Bourges, from 70° to 90° 20′ zenith distance. Now Bessel's table gives, for the horizon, about 36′ 30″; that is, 2′ 44″ too much.

It may be said that these errors afford no *practical* objection to the table, because observations are very rarely made at such altitudes: but surely they are objectionable in a *theoretical* point of view, since it is only the extreme cases that afford any test of the truth of the theory: for in common cases, all theories agree sufficiently well; and in fact, Mr. Bessel's supposition, that the density is so related to the height s as to be expressed by e^{-nas}, is contrary to all experience with respect to the distribution of temperature in the atmosphere.

I have to thank you for your Auxiliary Tables for 1823; but I must enter my formal protest against the decided manner in which you mention the differences between the declinations of Greenwich and of Königsberg.

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iii. *Specimen of* Mr. STOCKLER's *Inverse Method of Limits. In a Letter to* CHARLES BABBAGE, Esq., F.R.S.

DEAR SIR,

I have received from Mr. Stockler the manuscript of a work in Portuguese, dedicated to the Royal Society, and entitled *Methodo Inverso dos Limites.* I do not know that there is any immediate probability of its being made public: but I wish to ask your opinion of the degree of utility that is to be expected from these investigations, as far as you can judge from the specimen which I send you, containing what the author considers as the fundamental proposition of his method; a method of which the object can only be, as he observes, "to determine the law or the form common to all the series of which a given function can be the limit of expression; and which is therefore reducible to the solution of this single

PROBLEM.

Supposing x to be any function of any number of variable quantities, and representing by $\mathrm{F}x$ any function of x, and consequently of the same variable quantities that enter into the expression of x; to determine the form, or the general law, common to all the series of which $\mathrm{F}x$ can be the limit of expression.

SOLUTION.

Taking any state whatever of the magnitude of x to serve as a term or limit, to which all the others may be referred, we shall designate it by the name of the *Primitive State*, and all the others by the denomination of *varied* or *derivative states.* Then representing by x the primitive state of the quantity or function indicated by x, and any of its derivative states by $x + u$, we shall have $\mathrm{F}x$ for the primitive state of the function of x indicated by the characteristic F, or the magnitude of $\mathrm{F}x$ corresponding to the primitive state of the function represented by x, and $\mathrm{F}(x + u)$ will represent the magnitude of $\mathrm{F}x$ corresponding to $x + u$. Now, as the increment u is absolutely arbitrary, we may consider it as capable of admitting states of magnitude less than any other that may be assigned: and, therefore u is a variable without any limit to its diminution; whence it follows that $x = \lim(x + u)$; and $\mathrm{F}x = \lim \mathrm{F}(x+u)$. It may, consequently, be inferred that $\mathrm{F}(x+u)$ must be equivalent to $\mathrm{F}x$ more or less a function of x and u, or of u only, without limit to its diminution; so that, considering the most general form of $\mathrm{F}(x + u)$ after its separation into two parts, we shall have

$$\mathrm{F}(x + u) = \mathrm{F}x + \mathrm{V}\mathrm{F}'(x, u)$$

V being a function of u without limit to its diminution, an

$F'(x,u)$ a function of x and u capable of limitation. For the same reason, keeping always in view the most general form of the functions of x and u, we must have

$$F'(x,u) = F'x + V' F''(x,u),$$
$$F''(x,u) = F''x + V'' F'''(x,u).$$
$$F'''(x,u) = F'''x + V''' F''''(x,u), \&c.$$

V'; V'', &c., being functions of u without limit in diminution, and $F''(x,u)$; $F'''(x,u)$; &c., functions of x and u capable of limitation. Now the first of these conditions cannot be expressed in a more general manner, than by making

$$V = u\varphi u.$$
$$V' = u\varphi' u.$$
$$V'' = u\varphi'' u, \&c.$$

expressions in which φu; $\varphi' u$; $\varphi'' u$, &c., represent functions of u capable of limits, or constant quantities: and the substitution of these values, in the former equations, reduce them to

$$F(x+u) = Fx + u\varphi u F'(x,u).$$
$$F'(x,u) = F'x + u\varphi' u F''(x,u).$$
$$F''(x,u) = F''x + u\varphi'' u F'''(x,u), \&c.$$

and the substitution of each of these in the others gives us finally,

$$F(x+u) = Fx + u\varphi u F'x + u^2\varphi u\varphi' u F''x + u^3\varphi u\varphi' u\varphi'' u F'''x + \&c.$$

or, if we write x for u, and u for x, which in no way changes the function $F(x+u)$.

$$F(u+x) = Fu + x\varphi x F'u + x^2\varphi x\varphi' x F''u + x^3\varphi x\varphi' x\varphi'' x F'''u + \&c.$$

If we here observe, that u has no limit of diminution, and if we denote by $F0$, $F'0$, $F''0$, &c., the limits of Fu, or the values to which these functions are reduced by the substitution of a zero for the symbol denoting its root, we shall obtain ultimately from this formula the following equation.

$$Fx = F0 + x\varphi x F'0 + x^2\varphi x\varphi' x F''0 + x^3\varphi x\varphi' x\varphi'' x F'''0 + \&c.$$

and in this most general expression consists the solution of the problem proposed.

In the subsequent sections the author proceeds to introduce more particular values, for such of the quantities as here remain indeterminate: but you will be able to judge of the method that he employs by the first section, of which I have given you a translation. For my own part, I think that the substitution of $F'(x,u)$ in an argument inferred from reasoning on $F(x+u)$, as well as the exchange of x for u and u for x, when u only had before been supposed evanescent, requires something more of illustration than the learned and accomplished author has here thought it necessary to bestow on it, though I am not at all disposed to deny the general validity of his reasoning, or the truth of his conclusions.

Believe me, dear Sir,
Yours, very sincerely,
London, 19 *May*, 1823. * * *.

iv. *An easy Method of computing the Time of Conjunction in Right Ascension from an observed* Occultation.

I. Observe, if possible, the difference of apparent altitudes at the time of immersion, or emersion; if not, compute it either by finding the altitudes separately, or from the differences of declination, and right ascension, allowing for the change of declination between the conjunction in right ascension at Greenwich, and the time of immersion, by reckoning; and reducing the difference of declination in the ratio of the radius to the cosine of the parallactic angle (P☽Z), and that of right ascension in the ratio of the radius to the cosine of the same angle. (See *Astr. Coll.* No. III.)

II. The true distance at the time of immersion may be found, as in the correction of a lunar observation, by the method in the Appendix to the Requisite Tables, observing that the Reserved Logarithm will become simply log. (cos. P' − sin. A' sin. P), P being the horizontal parallax, P' the parallax in altitude, and A' the apparent altitude. This multiplier, however, may be altogether omitted without inconvenience, and the triangles may be treated as plane instead of spherical, the square of the true distance being equal to the sum of the squares of the semidiameter and of the difference of true altitudes, lessened by the square of the difference of apparent altitudes.

III. The square of the true distance being thus obtained, the distance of the star from the orbit may be found by reducing the difference of declinations at its conjunction in right ascension, in the ratio of the radius to the sine of the orbital angle; and the square of the nearest distance, being subtracted from the square of the true distances, will give the square of the distance from the point of the orbit nearest to the star, the place of which in the orbit is found from the cosine of the orbital angle. And in all these cases, the natural verse sines, taken from a good table, will serve instead of the squares. The time of immersion is found from the place in the orbit by means of the hourly motion, and may be employed for correcting the declination, and repeating the operation, when necessary.

I. *Example.* Suppose the emersion of υ ♌ to have been observed at Paris, 1822, Feb. 8, $10^h\ 9^m\ 11^s$: and the difference of altitudes of the star and the moon's centre, either observed or computed, to have been 2′36″: the semidiameter at the time being 15′ 18″, and the parallax in altitude 52′ 1″, whence the true difference of altitudes was 54′ 37″, the star being below the moon's centre.

II. The semi-diameter	15′ 18″	=	918″	square	842724
True diff. alt. . .	54 37	=	3277		10738729
Diff. app. alt. . .	2 36	=	156	A.C.	99975664
True distance . .	56 40	=	3400		11557117

III. Now in order to find the point of the orbit nearest to the star, we take the difference of declination at the conjunction, P. L. 41′58″. .6324

And add to it the log. cosec. and the log. sec.	62° 2′	.0539 .3289
Hence the distance is	37′ 4″	.6863
the motion in the orbit	19′ 41″	.9613

Then	37′.4″	= 2224″	square	4946176
Subtracted from				11557117
Gives	42′ 51″	= 2571		6610941
Deduct	19 41			

the remainder 23 10 is the motion in the orbit, which, at the rate of 31′ 30″ in an hour, gives $44^m\ 8^s$, to be added to the time of emersion, $10^h\ 9^m\ 11^s$, for the time of conjunction in right ascension, making $10^h\ 53^m.19^s$; which differs only by a second from the true term of conjunction, $10^h\ 53^m\ 18^s$.

A table of square numbers, like that of Professor Barlow, will be found very useful in these computations.

V. *Remarks on* Mr. PLANA's *Researches relating to Refraction. In a Letter to* Professor GAUTIER.

MY DEAR SIR,

I believe it is to you that I am indebted, or perhaps to Baron Zach, for the notice that Mr. Plana has been pleased to take of my papers on Refraction: and I consider myself as obliged to this justly celebrated mathematician, not only for the flattering terms in which he has mentioned my name, but also for the forbearance with which he has hinted at what appears to him to be an unfounded objection to Laplace's hypothesis; at the same time, that he has endeavoured to substitute another objection to that hypothesis, which will, perhaps, be still more easily superseded. I hope also to be allowed, in return for these services, to set Mr. Plana right upon a point of physical optics, respecting which he is both essentially and accidentally in error: essentially, because, he mistakes the ground upon which I have founded my optical reasoning; and accidentally, because the error, if it had existed, would have been of no consequence whatever to the result.

I might, perhaps, be justifiable in complaining, that in a section devoted to the history of the late researches on refraction, Mr. Plana has only mentioned my attempts, in order to express his surprise at this supposed error, and that he has not thought it necessary to take the slightest notice of the real innovation that I have ventured to make in the investigation. The history of my paper might have been expressed very shortly, by saying that it was "a Method of computing the Atmospheric Refraction, upon any possible hypothesis, by means of a series which expresses the density in terms of the integer *powers of the refraction itself*; a series converging *rapidly* in all ordinary cases, and converging *sufficiently*, even in the extreme cases near the horizon. Mr. Plana not having noticed this distinguishing characteristic of my little invention, I shall endeavour to impress it on his mind, by one more instance of the facility with which it may be employed; and I shall offer him, for this purpose, an example of its application to the hypothesis of Laplace, which is expressed in so intricate a form, as not to be of the most manageable nature, and as to be very liable to some misinterpretations.

My series, as it was actually employed for the construction of the table printed in the *Nautical Almanac*, (*Astr. Coll.* VIII. iii.) is $A = v\frac{r}{s} + (B - \frac{1}{2}s^2)\frac{r^2}{s^2} + Cv\frac{r^3}{s^3} + \frac{1}{2}C(B - \frac{1}{2}s^2)\frac{r^4}{v^4}$; and I have demonstrated that A being $= p$, and $\zeta = \frac{\mathrm{d}y}{\mathrm{d}z}$, and $\zeta' = \frac{\mathrm{d}\zeta}{\mathrm{d}r}$, B must be $\frac{\zeta''}{2mp}$, and $C = \frac{1}{6}\left(\frac{\zeta' s}{mpv} + \frac{\zeta}{mp^2}\right)''$, whatever may be the relations between the density z, and the pressure y: and if we put $\xi = \frac{\mathrm{d}\zeta}{\mathrm{d}x}$, we shall have, still more compendiously, $C = \frac{\zeta}{6mp^2}\left(1 + \frac{\xi}{m}\right) = \frac{B}{3p}\left(1 + \frac{\xi}{m}\right)$; since $\frac{\mathrm{d}x}{\mathrm{d}r} = \frac{\zeta v}{mpsz}$, and $\zeta' = \frac{\xi\zeta v}{mpsz}$.

Now in the hypothesis of Laplace, (*Méc. Cél.* X. §. 7. P. 264), "$u = s - 0{,}000293876\left(1 - \frac{\varrho}{(\varrho)}\right)$; $\varrho = (\rho)[1 + u.661{,}107]\,c^{-u.1348{,}04}$;" or, in the symbols of the series, "u" $= 1 - \frac{1}{x} - p(1 - z)$, and $z = (1 + \mu u)\,e^{-\nu u}$; making $661{,}107 = \mu$, and $1348{,}04 = \nu$.

Hence, we obtain $\mathrm{d}u = \frac{\mathrm{d}x}{xx} + p\mathrm{d}z$, and $\mathrm{d}z = \mu e^{-\nu u}\mathrm{d}u - \nu z\mathrm{d}u$; and making $\mu e^{-\nu u} - \nu z = U$, $\mathrm{d}z = U\mathrm{d}u = U\frac{\mathrm{d}x}{xx} + pU\mathrm{d}z$, $\mathrm{d}z - pU\mathrm{d}z = U\frac{\mathrm{d}x}{xx}$, and $\mathrm{d}z = \frac{U}{1 - pU}\frac{\mathrm{d}x}{xx}$: and $\mathrm{d}y$ being $= -mz\mathrm{d}x$, $\frac{\mathrm{d}y}{\mathrm{d}z} = \zeta = -mx^2\left(\frac{1 - pU}{U}\right) = mx^2\left(p - \frac{1}{U}\right)$; consequently $\mathrm{d}\zeta = 2\frac{\zeta}{x}\mathrm{d}x + mx^2\frac{\mathrm{d}U}{UU}$; $-mx^2\frac{\mathrm{d}U}{UU}$;

but $\mathrm{d}U = -\mu\nu e^{-\nu u} - \nu\mathrm{d}z = -\mu\nu e^{-\nu u}\frac{\mathrm{d}z}{U} - \nu\mathrm{d}z$: and initially, when $u = 0$, $U^{\smile} = \mu - \nu$, $\mathrm{d}z^{\smile} = \frac{U}{1 - pU}\mathrm{d}x$, or if $\nu - \mu = \lambda$, $\mathrm{d}z^{\smile} = \frac{-\lambda}{1 + p\lambda}$, $\zeta^{\smile} = mp + \frac{m}{\lambda}$, $\mathrm{d}U = \mu\nu\frac{\mathrm{d}z}{\lambda} - \nu\mathrm{d}z = -\mu\nu\frac{\mathrm{d}x}{1 + p\lambda} + \frac{\nu\lambda}{1 + p\lambda}\mathrm{d}x$, and $\frac{\mathrm{d}\zeta^{\smile}}{\mathrm{d}x} = \xi = 2\zeta + \frac{m}{\lambda\lambda} \cdot \frac{\nu\lambda - \mu}{1 + p\lambda} = 2\zeta + \frac{m\nu}{\lambda\lambda} \cdot \frac{\lambda - \mu}{1 + p\lambda} = 2\zeta + \frac{m\nu}{\lambda\lambda} \cdot \frac{\nu - 2\mu}{1 + p\lambda}$.

The numerical values of the coefficients, taking $m = 798$, as supposed by Laplace, will be $B = \frac{\zeta^{\smile}}{2mp} = \frac{1}{2} + \frac{1}{2p\lambda} = \frac{1}{2} + \frac{3403}{1373.86} = 2.977$, and $C = \frac{B}{3p}\left(1 + \frac{\xi}{m}\right) = \frac{B}{3p}\left(1 + \frac{2\zeta}{m} + \frac{\nu}{1 + p\lambda} \cdot \frac{\nu - 2\mu}{\lambda\lambda}\right) = \frac{.9923}{p}\left(1 + .0074 + \frac{1348 \times 25.82}{1.2019 \times 687 \times 687}\right) = 3141\,(1.0074 + .0614) = 3141 \times 1.0688 = 3356$. In the *Nautical Almanac*, the values, obtained from the observed refractions only, are $B = 2.97$ and $C = 3600$: and the difference in the results of the computation will be insignificant even at the horizon.

It is almost unnecessary to remark, that a hypothesis, so well supported by direct observation, can scarcely be very materially erroneous. With respect to the variation of temperature in ascending, we may represent it by making $z = y(1 + tx - t)$; (*Collect.* VI. i. 7. D.); t being either constant or variable, according to the conditions of the hypothesis; then if f be the number of feet required for a depression of a degree of Fahrenheit, we shall have $t = \frac{20\,900\,000}{476f}$, and $f = \frac{43907}{t}$; but $\mathrm{d}z = \mathrm{d}y\frac{z}{y} + ty\,\mathrm{d}x + (x - 1)\,y\mathrm{d}t$; consequently $t = \frac{\mathrm{d}z}{y\mathrm{d}x} - \frac{z}{yy}\frac{\mathrm{d}y}{\mathrm{d}x} - (x - 1)\frac{\mathrm{d}t}{\mathrm{d}x}$, and $\mathrm{d}t^{\smile} = \mathrm{d}\left(\frac{\mathrm{d}z}{y\mathrm{d}x} - \frac{z}{yy}\frac{\mathrm{d}y}{\mathrm{d}x}\right)$

$-\,\mathrm{d}t$; whence $2\mathrm{d}t^{\smile} = \mathrm{d}\left(\frac{\mathrm{d}z}{y\mathrm{d}x} - \frac{z}{yy}\,\frac{\mathrm{d}y}{\mathrm{d}x}\right)$; and since $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\zeta\mathrm{d}x}{\mathrm{d}x} - mz$, $\mathrm{d}t^{\smile} = \frac{1}{2}\mathrm{d}\left(\frac{mzz}{yy} - \frac{mz}{y\zeta}\right) = \frac{m}{2}\mathrm{d}\left(\frac{zz}{yy} - \frac{1}{\zeta}\,\frac{z}{y}\right) = 2\mathrm{d}\,\frac{z}{y} - \frac{1}{\zeta}\mathrm{d}\frac{z}{y} - \mathrm{d}\,\frac{1}{\zeta}$; but $\mathrm{d}^{\smile}\,\frac{z}{y} = \mathrm{d}z - \mathrm{d}y = (1 - \zeta)\,\mathrm{d}z$, and $-\,\mathrm{d}\,\frac{1}{\zeta} = \frac{\mathrm{d}\zeta}{\zeta\zeta} = \frac{\xi\mathrm{d}x}{\zeta\zeta} = -\,\frac{\xi\mathrm{d}z}{m\zeta}$, and $\frac{\mathrm{d}t^{\smile}}{\mathrm{d}z} = \frac{m}{2}\left(2 - 2\zeta - \frac{1}{\zeta} + 1 - \frac{\xi}{m\zeta}\right) = \frac{m}{2\zeta}\left(3\zeta - 2\zeta^2 - 1 - \frac{\xi}{m}\right)$. Now we have found ζ in the present case $= 1.396$, and $\frac{\xi}{m} = .0688$; whence $\frac{\mathrm{d}t^{\smile}}{\mathrm{d}z} = \frac{m}{2\zeta}(4.188 - 3.898 - 1 - .069 = -\,.779\frac{m}{2\zeta}$; which being negative, it follows that t increases with the elevation, as z diminishes, and that the variation of temperature becomes greater in ascending.

Mr. Plana has remarked, that "en suivant les conséquences de l'hypothèse de M. *de Laplace*, l'on pourrait ajouter, que la pression barometrique, qui *en résulte*, est loin de s'accorder avec celle *observée* par M. Gay-Lussac au point supérieur de son ascension aérostatique." I shall not undertake to criticize Mr. Plana's Memoir, especially without having had time to read it through with attention; but I am utterly at a loss to conceive by what witchcraft he has been able to compute the barometrical pressure *resulting* from Laplace's hypothesis at the height attained by Gay-Lussac, if that height was only deduced from the actual observation of the *barometer*. Perhaps, indeed, the aëronauts were able to measure, with their sextant, a variety of angles, subtended by distant terrestrial objects: and if such was the fact, my question is answered.

I shall now proceed to discuss the second passage in which Mr. Plana has done me the honour to mention me. "Je crois avoir reconnu," he observes, (p. 301), que le Dr. *Young* n'est pas parti de la véritable équation du problème dans un de ses écrits, ayant pour titre *Corrections for Refraction*, Le D. Y. après avoir pris pour base cette équation très exacte [$d\theta = \frac{du}{\sqrt{(r^2 - u^2)}}$], donnée antérieurement par *Lambert*, suppose la perpendiculaire u, dans la courbe décrite par le corpuscule de lumière, telle que l'on a $u = \frac{b}{1 + M\varrho}$, b étant un constant convenable." This value of u is inconsistent, he observes, with the demonstration of Laplace and others, and he continues; "Pour redresser cette erreur, il faut supposer à la variable u une expression de la forme $u = \frac{b}{\sqrt{(1 + M\varrho)}}$... .Cette méprise du Dr. Young est tellement singulière, que je crois de mon devoir de rapporter ici le raisonnement même que ce physicien...a fait pour établir son expression differentielle de la réfraction." In the passage quoted, I have called the refractive density $1 + pz$, "p being a *very small* fraction."

Mr. Plana does not seem to be aware that, in the theory of optics, which I have long since advanced, and which has of late years begun to acquire some considerable popularity, the demonstration, to which he alludes, as deduced from the laws of central forces, is wholly inadmissible, except as a mathematical fiction: and he must show, that the refractive density does *not* vary in proportion to the actual density multiplied by a very small fraction, and increased by unity, before he can establish this charge. But even supposing it established, that I ought to have taken $\sqrt{(1 + M\varrho)}$ instead of $1 + p\varrho$, it is quite clear, that since $\sqrt{(1 + M\varrho)} = 1 + \frac{1}{2} M\varrho - \frac{1}{8} M^2 \varrho^2$...and since ϱ is always less than unity, the error could only amount to $\frac{1}{8}$ of the square of the coefficient M, that is, to the square of $\frac{1}{1700}$, and that such an error would have been wholly insensible.

Believe me, dear Sir, yours, very sincerely,

9 *June*, 1823. * * *.

Art. XIV.—MISCELLANEOUS INTELLIGENCE.

I. Mechanical Science.

1. *Bridge at Menai Straits.*—The first great iron plate for forming the fastening of Menai bridge was laid in its proper position in the bottom of one of the caverns which had been formed out of the solid rock on the Anglesea shore, on Easter Monday. Sir Henry Parnell and Mr. Telford attended on the occasion, and did not leave until all the necessary arrangements were adopted for proceeding immediately with the putting up of the large quantities of the iron-work which have arrived from Shropshire, for forming the suspending cables. Nearly the whole of the bridge masonry is completed, the pyramids for supporting the cables of 50 feet in height above the top of the main piers will be finished early in summer, and the iron-work is going on so rapidly at Mr. Hazeldine's forges, that there is a certainty of this great work being completed in the most satisfactory manner for the use of the public, in little more than another year.

2. *Gas Lighting.*—The length of streets already lighted in this metropolis with gas is 215 miles ! and the three principal companies light 39,504 public lamps, and consume annually about 33,158 chaldrons of coals.

3. *Artificial Formation of Haloes.*—The following experiment, which illustrates in a pleasing manner the actual formation of haloes, has been given by Dr. Brewster. Take a saturated solution of alum, and having spread a few drops of it over a plate of glass, it will rapidly crystallize in small flat octoëdrons scarcely visible to the eye. When the plate is held between the observer and the sun or a candle, with the eye very close to the smooth side of the glass plate, there will be seen three beautiful haloes of light at different distances from the luminous body. The innermost halo, which is the whitest, is formed by the images refracted by a pair of faces of the octoëdral crystals, not much inclined to each other; the second halo, which is more coloured, with the blue rays outwards, is formed by a pair of faces more inclined; and the third halo, which is very large and highly-coloured, is formed by a still more inclined pair of faces. Each separate crystal forms three images of the luminous body placed at points 120° distant from each other in all the three haloes; and, as the numerous small crystals have their refracting faces turned in every possible direction, the whole circumference of the haloes will be completely filled up.

The same effects may be obtained with other crystals, and when they have the property of double refraction, each halo will be either doubled when the double refraction is considerable, or rendered broader or otherwise modified in point of colour, when the double refraction is small. The effects may be curiously varied by crystallizing upon the same plate of glass crystals of a decided colour, by which means we should have white and coloured haloes succeeding each other.—*Edin. Phil. Jour*. viii. 394.

4. *On the Electricity produced by Pressure.*—A very important paper, on the developement of electricity by pressure, and the laws of that developement, by M. Becquerel, is to be found in the *Annales de Chimie*, xxii. 5. We cannot do more at present than translate the summary given at the conclusion of the paper.

It is seen, then, that all bodies assume two different electric states by pressure: that, in two bodies being perfect conductors, this state of equilibrium ceases, at the moment the pressure is removed, but if one be a bad conductor, the effect of the pressure continues for a longer or shorter time: that the pressure alone maintains the equilibrium of the two fluids, placed on each of the surfaces; for if the pressure be diminished, and, at the end of a certain time, the bodies be removed from the compression, they will be found to have the electricity, due only to the last or remaining pressure: that heat modifies the developement of electricity in a particular manner: that the intensity of the electricity increases, at first, directly as the pressure; and that it is probable this proportion diminishes at high pressures, as the bodies lose their power of being compressed: finally, it is rendered probable, that the light which is disengaged in powerful concussions, is due to the rapid recombination of the two electric fluids developed on the surfaces at the moment of compression.

5. *Light evolved by Pressure.*—We extract the following passage from the paper above referred to. Considering the increased developement of electricity in bodies, by the augmentation of pressure, ought we not to refer to this cause certain luminous phenomena, of which the origin is as yet unknown? For instance, it is said, that in the Polar Seas, it frequently happens, that the blocks of ice which strike together evolve light. These enormous blocks arriving one against the other, with considerable motion, will be submitted to great pressure, and thus the two blocks be placed in two different electric states. At the moment the compression ceases, the two fluids will recombine, in consequence of the conducting power of the ice; and may not the light disengaged be the result of the combination of the electric fluids *?

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* See also the light from the falling of a glacier, ix. p. 426.

Iron, submitted to successive blows, also becomes luminous. Are not the same electric phenomena of pressure produced here, as when two masses of ice strike together?

6. *Developement of Electricity by two pieces of the same metal.*—Among the applications of the electro-magnetic multiplier, is the following:—If two pieces of the *same* metal are plunged, at different moments, into an acid capable of acting on them, that which was first introduced will act as the most positive metal to the other. The experiment may be made very well with zinc and diluted muriatic, or sulphuric acid.—Avogadro, *Annales de Chim.*

7. *Variation of Thermometers.*—In the last volume of this Journal, p. 441, notice was taken of an observation made by M. Flaugergues on the instability of the freezing point of ice, as laid down on thermometers. The effect was not observed in alcohol thermometers or in mercurial thermometers open at the top, and was attributed to the gradual yielding of the glass bulb to the external atmospheric pressure, which, diminishing its bulk, raised the surface of the mercury in the tube, and rendered the scale incorrect.

M. Bellani has entered into the investigation of an analogous error in thermometers, and published the result of his researches in the *Giornale di Fisica*, v. 268. He finds that a mercurial thermometer, being made in the usual manner, and the freezing point of water marked on it from experiment, if it be laid aside awhile, and again plunged in melting ice, the mercury will stand higher than before; and that if it be put aside again, and then again tried, the mercury will be higher still, until, at the end of a certain time, a year or so, the effect of elevation will cease.

It was found from numerous experiments, that the result was not influenced by the various qualities of the glass used in the instrument; by the more or less perfect exclusion of air from the bulb or tube; by the constant horizontal, perpendicular, or inverted position of the instrument; by the open or closed extremity; by the longer or shorter time of remaining in the ice; or by the compression of the surrounding ice. Neither was it found to be peculiar to mercurial thermometers, but was exhibited by alcohol thermometers, though in a less degree.

M. Bellani at last ascertained, that the effect was due to a gradual and slow contraction of the glass after having been highly heated, which contraction, as long as it continued, diminished the bulk of the instrument, and consequently forced the fluid into the tube. This effect he illustrates in the following manner:—Take a Florence flask, or any similar thin glass vessel, such as a matrass with a long narrow neck, shortly after it has come from the glass furnace, it not having been annealed in the oven; introduce shot or sand into it till it almost sinks in water, seal it hermetically, and draw out one part of the neck until not more than a line in diameter, that part being about an inch in length; fasten a small basin on the top of the neck with wax, and then, putting the instrument in water of a certain temperature, 40° F. for instance, put weights in the cup till the surface of the water is at the middle of the narrow part of the neck; then lay the instrument aside for some days, or better still, some weeks or months, and after that time, again immerse it in the same water at the same temperature and pressure, and with the same weight; the instrument will now sink lower than before, in consequence of its diminished bulk from gradual contraction of the glass.

It was found that, although the effect was greatest after the glass had been rendered soft by heat, yet that it occurred also when the elevation of temperature had not extended nearly to the softening of the glass, and indeed more or less upon every rise of temperature. We have referred to an illustration of this at p. 160 of our last Number. Hence two kinds of irregularity in thermometers arise from the same cause. The one is manifested soon after the formation of the instrument, increases to a certain degree, and then remains stationary: this may be rectified by elevating the scale of the instrument the required quantity. The other takes place at every change of temperature; it is small and scarcely perceptible, with small changes of temperature, but by considerable changes becomes very evident and important.

Singular consequences sometimes result from the influence of these changes. If two liquids be taken of different temperatures, a greater difference will be found between them, by trying the hot fluid, and then the cold fluid by the same thermometer, than what will appear to exist by trying the cold fluid first. Again, if a new thermometer be graduated by an old one preserved as a standard, although it may be made to agree with it, yet, after a while, the two will not accord; and if two old thermometers be taken that do agree, and the one be heated whilst the other remains unused, they will no longer indicate the same temperatures.

The reason now becomes evident, why alcohol thermometers are so much less affected in this manner, than those filled with mercury. Alcohol expands several times more than mercury, so that an instrument constructed with it having a tube of the same diameter, and degrees of the same size, will require a bulb several times less than if mercury had been used. Hence, as the elevation is in proportion to the capacity of the bulb, independent of the liquid it contains, the alcohol thermometer will exhibit a much smaller effect than the mercurial instrument.

8. *Variation of Thermometers.*—MM. A. de la Rive and F. Marcet, have also investigated the elevation of the mercury in thermometers, which is due to the cause pointed out by Mr. Flaugergues, (xiv. 441,) namely, the continued pressure of the air on its external surface: and by opening the top of the thermometer; by submitting the instrument to condensed or rare atmospheres; and by comparison with thermometers otherwise constructed, have abundantly proved the effect due to this power. These philosophers had occasion also to remark some curious effects due to the absorption and evolution of heat, by the expansion and condensation of gases, which, however, we cannot at this time further attend to, than by copying the conclusions at the end of the memoir.

1. That atmospheric pressure exerts an influence on the bulk of thermometer bulbs. 2. That in experiments, where this effect may influence the results, it is better to use thermometers open at the top. 3. That certainly cold is produced in making a vaccuum by the air pump, but in smaller quantity than was supposed *. 4. That when gases enter an exhausted vessel, there is at first a production of cold, and then of heat. 5. That various modifications may render the cold produced at the moment of the entrance of air into a vaccuum, more intense.—*Bib. Univ.* xxii. 265.

9. *On Variations of Barometers and Thermometers.*—Sig. Bellani has undertaken a series of experiments, to determine whether the air or vapour, the last portions of which are found to remain so obstinately in barometers and thermometers, is introduced with the mercury, or is a portion of that which originally occupied the tube before the introduction of the metal. The conclusion he comes to is, that it is always a portion of that which previously adhered to the glass, and that mercury is utterly incapable of absorbing either air or moisture. The extraordinary way in which air and water is held at it were in a film over glass, is insisted upon, and reference made to many authors in proof of it. The following, however, are more interesting, as being some of the facts he advances to prove that the mercury never contains either of these substances. Fill a barometer tube and boil it very carefully; then prepare a kind of funnel made of a small capillary tube, which will reach through the mercury in the barometer tube to the closed end, and is enlarged at top; let it be recently made, so as to be dry, and introduce it into the barometer tube; prepare some mercury by agitating it in a bottle with water and air, then drying its surface with bibulous paper, and afterwards passing it through paper cones three or four times into dry vessels; pour a little of this

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* It has been stated, that when one of M. Breguet's metallic thermometers has been used, the diminution of temperature has amounted to 50°.—Ed.

mercury into the funnel tube, and with a horse-hair or fine wire remove the air, so that the column may be continuous; then pour in so much of this prepared mercury as will fully displace the mercury that was boiled in the tube; afterwards remove the funnel tube, and put the barometer to its proper use. It will be found to stand exactly at the same height as before in the same circumstances; and if the mercury be now boiled in the tube none of those bubbles will appear which arose on the first boiling; care being taken throughout, that the inner surface of the tube has not been exposed to the air.

Perhaps an easier mode of making the same experiment is to make the barometer terminate at top in a bulb, which will hold more mercury than is required to fill the tube: then when it is boiled it need only be placed upright in a basin of common mercury, and when inclined the mercury will enter and replace that which was boiled in the instrument; the results will be as above.

An experiment proving the same thing may be made still more easily thus: fill a mercurial thermometer and boil it well; then heat it till nearly all the mercury is expelled, but preserve its open extremity under common mercury: the latter metal will enter as the instrument cools, and behave in every respect as the well-boiled mercury did.—*Giornale di Fisica,* vi. 20.

10. *Maximum Density of Water.*—The maximum density of water is a point which, though frequently spoken of and sought after, has never been accurately ascertained. Mr. J. Crichton, of Glasgow, who has lately been engaged in determining the specific gravity of certain fluids by means of adjusted balls of glass, was so satisfied with the simplicity and accuracy of the method, that he determined to apply it to the investigation of the point above mentioned, and after much careful experiment has fixed it with apparently great accuracy at 42. 3° F.

In a first experiment with these balls, one, which was just poised in water at 33°, had the same property near 51°; this gave 42° for the point of greatest density, supposing the expansion equal for equal differences of temperature above and below the maximum density.

Many precautions are required in these kind of experiments: whilst cooling the water it should be kept as still as possible, agitation charging it with air; the presence of air-bubbles should be very carefully attended to, for when one happens to adhere to the ball, the experiment is vitiated. An uniform temperature should be attended to in every part of the mass of water, and the absence of currents ascertained. The delicacy of the ball itself may be imagined, when it is understood that the removal of the 6000th part of a grain, or as little as could possibly be ground off, has been too much. At first spherical balls were used, but afterwards they were made in the form of parabolic spindles, sharp at the ends, of about an inch in length and $\frac{4}{10}$ in diameter. In order to ensure perpendicularity of the axes, before such a ball was hermetically sealed, a small globule of mercury was introduced, which effectually answered the purpose.

The mode of observation was as follows:—A jar with distilled water, thermometers and a bulb being arranged, the temperature being so low that the ball remained at the bottom of the water, was carefully watched with a large lens until the ball quitted the bottom, and at this moment the thermometers were noted. When the ball had risen a little, a small rod was cautiously let down, and, without agitating the water, gently made to touch the ball; it descended, but instantly rose: this is a very delicate part of the experiment, and if overdone loses its effect. It was repeated frequently, and the ball re-ascended each time with accelerated velocity. The thermometer indicating an increasing temperature, the ball finally became stationary at the surface; from time to time it was touched as before, but, as the temperature rose, the tendency of the ball to ascend, judging by the velocity with which it did so, each time diminished. Its upper extremity, by degrees seemed to press more feebly on the surface of the water, till at last a fine thread of separation became visible. The degree by the thermometers was again marked, and, as they continued slowly to rise, the ball gradually fell to the bottom of the jar. The intermediate point, between the two points noted, was then ascertained, and considered as the point of maximum density of the water. It appeared, from all the experiments, to be a little above 42°; and, from one experiment, as before mentioned, to be 42.3°.—*Ann. Phil.* N.S. v.

11. *Tenacity of Iron Wire.*—At page 136, an account is given of an economical wire suspension-bridge erected at Annonay, by M. Seguin. It was expected that the difference of temperature at different seasons would influence the strength of this and similar bridges, and render it weaker at one time than another. M. Dufour has, therefore, undertaken some experiments, with a view of ascertaining any change in tenacity dependent upon such alteration of temperature. Some iron wire was procured, $\frac{1}{30}$ of an inch in diameter, and the weight required to break it ascertained from the mean of several experiments. A portion was then passed through a hollow vessel, filled with a frigorific mixture, which lowered the temperature to $-8°$ F. In three experiments, in which wires, thus circumstanced, were broken by weights applied to them, the separation took place *out* of the vessel, and the weight required was the same as before. The vessel was then filled with boiling water, and the wire passing through it tried as before. It broke once in the vessel, and once out of the vessel, the latter by the smaller weight.

Finally, two vessels were then disposed on the wire, one containing the frigorific mixture, the other boiling water; the wire gave way between them, requiring the same weight as before.

It may thus be considered as demonstrated, that between the limits of temperature indicated *i. e.*, 212° and — 8° F.; change of temperature has no influence on the tenacity of iron wire. —*Bib. Univ.*, xxii. 220.

12. *Electro-Magnetism. New Experiments by M. Seebeck on Electro-Magnetic Action.*—This gentleman, member of the academy of Berlin, has discovered that an electrical circuit can be established in metals, without the interposition of any liquid. The electrical current is established in this circuit by disturbing the equilibrium of temperature. The apparatus for exhibiting this action is very simple. It may be formed of two arcs of different metals; for example, copper and bismuth soldered together at the two extremities, so that together they make a circle; it is not even necessary that the metallic pieces should have the form of an arc, or that their union have that of a circle; it is enough if the two metals form together a a circuit; that is, a continuous ring of any figure. To establish the current, we heat the ring at one of the two places where the two metals are in contact. If the circuit be composed of copper and bismuth the positive electricity will assume; in the part which is not heated, the direction of the copper towards the bismuth; but if the circuit be composed of copper and antimony, the direction of the current, in the part not heated, will be from the antimony towards the copper. These currents can be discovered only by the magnetic needle, on which they exercise a very perceptible influence. Henceforth we must distinguish this new class of electric circuits by a significant denomination; as such, the expression *thermo-electric circuits*, or perhaps *therm-electric*, are proposed. We can, at the same time, distinguish the galvanic circuit by the name *hydro-electric.*—See xiv. 42.

13. *On the Oscillations of Sonorous Chords.*—In a science of such universal interest as music, which is the object of discussion, not only of the musician, but of the mathematician and the natural philosopher, it is remarkable what a discordance of opinion there exists with regard to those sounds called harmonics, and even with regard to the oscillations of sonorous chords. The following interesting theorem removes all obscurity from these subjects.

If any two sonorous chords, A and B, be so placed, as that the oscillations of one shall cause the air to act upon the other, as in all stringed musical instruments, and if A oscillates, *m* times, while B oscillates *n* times, *m* and *n*, being any whole numbers prime to each other; then, if either of these chords, as A, is put in motion, the action of the air will divide B into *m* equal parts, each of which will oscilate *n* times, while A oscillates only once.

This theorem is the base of the theory of harmonics. It was deduced from a property demonstrated by Lagrange, in Sect. 6. *Mec. Analytique*, that a vibrating cord is susceptible of being divided into any number of equal parts, each of which would vibrate as if isolated. It affords a refutation of (what geometers seemed not absolutely to doubt) the assertion of Rameau, that every fundamental note in music is accompanied with its octave, twelfth, and seventeenth. It proves that, whether a sonorous homogeneous chord of uniform solidity has one, two, or three species of vibrations, these oscillations being necessarily performed in equal times, it cannot produce but one single note at a time. It is remarkable, that while the illustrious geometer just named had the proof of the fallacy of the received theory of harmonics before him, he was framing an hypothesis to account for its truth.

ii. CHEMICAL SCIENCE.

1. *A new Fluid discovered in Minerals.*—A new fluid, of a very singular nature, has been recently discovered by Dr. Brewster, in the cavities of minerals. It possesses the remarkable property of expanding about thirty times more than water; and, by the heat of the hand, or between 75° and 83°, it always expands so as to fill the cavity which contains it. The vacuity which is thus filled up is of course a perfect vacuum, and, at a temperature below that now mentioned, the new fluid contracts, and the vacuity re-appears, frequently with a rapid effervescence. These phenomena take place instantaneously in several hundred cavities, seen at the same time. The new fluid is also remarkable for its extreme volubility, adhering very slightly to the sides of the cavities, and is likewise distinguished by its optical properties; it exists, however, in quantities too small to be susceptible of chemical analysis. This new fluid is almost always accompanied with another fluid like water, with which it refuses to mix, and which does not perceptibly expand at the above-mentioned temperature. In a specimen of cymophane, or chrysoberyl, Dr. Brewster has discovered a stratum of these cavities, in which he has reckoned, in the space of $\frac{1}{4}$ of an inch square, 30,000 cavities, each containing this new fluid, a portion of the fluid like water, and a vacuity besides. All these vacuities simultaneously disappear at a temperature of 83°.

If such a fluid could be obtained in quantities, its utility in the construction of thermometers and levels would be incalculable. There are many cavities in crystals, such as those opened by Sir Humphry Davy, which contain only water, and which, of course, never exhibit any of the properties above described.

An account of these results was read before the Royal Society of Edinburgh, on the 3d and 17th of March.—*Edin. Phil. Jour.* viii. 400.

[We have seen a most curious and satisfactory specimen of amethyst quartz, containing the fluid above described by Dr. Brewster, in the collection of Thomas Allan, Esq. of Edinburgh. It exhibits three distinct oblong cavities, which, when the crystal is very slightly warmed, are to all appearance empty, but, upon cooling it by immersion in water, or by holding it against any cold substance, a portion of liquid is immediately perceived in each of the cavities, which gradually disappears as the crystal becomes less cold. The appearances are such as one might expect would arise from very highly condensed carbonic acid contained in the bubbles, assuming alternately the liquid and gaseous form, by very slight elevations and depressions of temperature.—Ed.]

2. *Crystallized Deposit in the Essential Oil of Bitter Almonds.* Mr. Hendrie has just put into my possession a considerable portion of white crystalline matter, which, he observes, always separates from the above oil, when it is kept for some time, partially exposed to air. The crystals are flattened rhombic prisms. When cleared of the adhering oil, they are transparent, somewhat acrid and gritty upon the tongue, fusible and volatile at a heat of about 300°—insoluble in water, but readily and abundantly soluble in ether and alcohol; the latter depositing a white powder, when mixed with water. They dissolve in solutions of ammonia, potassa, and soda, and are not decomposed when boiled with nitric acid. Their further properties I have not yet had an opportunity of examining, but the above shew that they are peculiar.—W. T. B.

3. *On a new Compound of Iodine. Iodide of Carbon?*—I Signori Ferrari e Frisiani, whilst preparing the iodate and hydriodate of potassa, observed the production of a new compound of iodine. It may be obtained thus:—Heat an ounce of iodine, with a little water, on a sand-bath, and add to it, by degrees, about two ounces of potash; when the two salts above mentioned will be formed. In order to saturate the excess of alkali, pour in, by degrees, a tincture composed of one ounce of iodine to six ounces of alcohol, specific gravity .837. When the re-action of the tincture on the potash is finished, pour the hot liquor on a filter, and the liquid which passes through will, as it cools, deposit yellow crystals, of the substance; they should be carefully washed in cold water, to remove all the iodate and hydriodate of potash. Another method is, to take the alcoholic solution of the two salts, prepared as above, and distil it; and when the fluid which comes over ceases to be coloured, to change the receiver; the colourless liquor then obtained, upon cooling, deposits very pure crystals, of the sub-

stance in question. If the distillation be suspended from time to time, and the retort allowed to cool, beautiful crystals of the substance form in it. If strong alcohol be used in the above operations, and but little water, then, upon adding water to the filtered liquor, the substance is precipitated in abundance.

This substance is solid, of a lemon yellow colour, tastes like nitric ether, and has an odour like that of saffron. Its form is a compressed hexahedron (esaedro schiacciato). It is insoluble in water, alkalies, or acids, but soluble in alcohol and ether. It fuses and sublimes by a gentle heat, but at a higher temperature becomes discoloured, is decomposed, and evolves vapours of iodine, leaving behind a mere trace of carbon.—*Giornale di Fisica*, v. 241.

Il Sig. Taddei has more lately resumed the examination of this substance, particularly with regard to its composition. He recognises in it the same body as that discovered by M. Serullas, and which the latter chemist formed in various ways, as by the action of potash on an alcoholic solution of iodine; by the action of alloys of potassium and antimony on a similar solution; and by passing water and iodine in vapour over hot charcoal.

Taddei found the substance to act on mercury, copper, and silver, forming iodides of these metals. When raised to a high temperature it was decomposed, hence he endeavoured in this way to ascertain the presence of hydrogen in it. No gas could, however, be obtained from it, and the absence of hydrogen was considered as established. The presence of carbon was ascertained in the residuum after decomposition by its producing carbonic acid when burnt in oxygen, and by its converting sulphate of barytes into sulphuret, which, on treatment with an acid, gave sulphuretted hydrogen gas.

The next object was to ascertain the quantities of the two elements found in it. The iodine was estimated thus: a given weight was decomposed by heat in a long tube of glass, and the iodine washed out by alcohol; the solution was diluted with water, and sulphuretted hydrogen gas passed through it; when it was presumed that all the iodine had been converted into hydroidic acid, the sulphur thrown down was collected, weighed, and the quantity of iodine inferred by the theory of proportional quantities. The carbon was carefully collected, introduced into a porcelain tube, to one end of which was attached a bladder containing a portion of oxygen, whilst from the other a tube led to a mercurial apparatus; the tube was then heated, the charcoal burnt, and its quantity estimated from the quantity of carbonic acid gas produced. Nearly the same experiment was repeated on the original iodide of carbon, and the same quantity of carbonic acid gas obtained.

The results of these experiments give the proportion of the carbon to the iodine as 1 to 17 by weight, and M. Taddei concludes, therefore, that the substance is a protiodide of carbon.

It ought, however, to be noticed that M. Serullas considers the body as a triple compound of carbon, hydrogen, and iodine, analogous to the one described by Mr. Faraday, as do also I Sig. Frisiani and Ferrari, but they have given no precise experiments on the subject. A proportion of hydrogen would make so small a part of the weight of the substance as easily to escape notice, unless carefully looked for.—*Giornale di Fisica*, vi. 65.

An elaborate paper has also appeared on this subject, by M. Serullas, in the *Annales de Chimie*, xxii. 172; for a full account of which, see the *Foreign Science*, p. 297. By his analysis, it appears to be a triple compound, and not an iodide of carbon; and it is remarkable, that the composition he has given is as nearly as possible that of the compound, described and analyzed by Mr. Faraday.—*See* Vol. xiii. p. 429.

4. *Triple Compounds of Chlorine.*—M. Despretz has read a memoir on this subject to the Academy of Sciences; the liquids which principally engaged his attention were those produced by the action of chlorine on olefiant gas, alcohol, and ether. The first of these liquids has been considered as a compound of equal volumes of chlorine and olefiant gas, a result which was confirmed by direct experiment. As to the liquid formed by the reaction of chlorine on alcohol, it proved to be a compound of one volume of chlorine and two of olefiant gas. The two liquids obtained by chlorine from ether have not been so accurately examined; but one of them is considered as a new compound of chlorine and olefiant gas.

In examining the action of olefiant gas on the chlorides of sulphur and iodine, M. Despretz observed some remarkable results. The chloride of iodine gave two substances, the one a colourless liquid with an agreeable taste and smell, and crystallizing in plates at 32°; the other resulting from the action of a greater quantity of olefiant gas, was white, solid, and crystalline.

With chloride of sulphur, a viscid liquid was produced, more fixed than water, of a disagreeable odour, and difficultly combustible.—*Ann. de Chim.* xxi. 437.

5. *Action of Chlorine on Muriate of Iron, &c.*—M. Van Mons saturated a concentrated solution of proto-muriate of iron with chlorine; it became of a deep brown colour, did not give out the odour of chlorine, tasted very astringent, and slightly acid, and sweet. After some time, golden-coloured crystals formed in the solution, and chlorine was developed in great abundance. These crystals liquefied in the air, and could not be again crystallized.

Gmelin, by passing chlorine through a solution of ferro-prussiate of potash, obtained a salt in fine rose-coloured crystals. It was composed of two proportions of prussic acid, one proportion of potash, and half a proportion of protoxide of iron.—*Giornale di Fisica.*

6. *On the Preparation of Potassium and Sodium.*—It is well known to chemists, that the frequent failures in the preparation of the alkaline metals arise from the high heat required in the operation, which frequently fusing or cracking the lute on the barrel, exposes it to the air and fire, when it is soon burnt, and the product either partly or entirely lost. The object of M. Brunner, who is the author of the following experiments, was to perform the operation at a comparatively low temperature, which he has been enabled to effect by the following apparatus.

The retort is a spheroidal iron bottle, about half an inch in thickness, and capable of holding about a pint of water; a gun-barrel bent into this form (∩) screws into it at the shorter end. When the retort is charged and luted, it is placed in a furnace, so that the longer part of the bent gun-barrel may pass out at the bottom, or in front, in a direction nearly perpendicular, the bent part itself remaining in the furnace; and that it may be protected from the fire, it is wound round with iron wire. The receiver is a cylindrical copper vessel, with an opening at the top to receive the end of the gun-barrel, and a tube passing from the side to convey away the gas produced in the operation. It is placed, when in use, in water or ice.

The following is an instance of its use: the retort was cleaned, dried, and heated, and then four ounces of fused caustic potash introduced in small portions alternately with six ounces of iron turnings broken in a mortar, mixed with one ounce of pulverized charcoal. The whole was stirred together, and covered with two ounces of iron turnings. The retort being luted, the barrel adapted, the whole placed in the furnace, and a glass tube attached to the end of the barrel, that the progress of the operation might be watched, the fire was lighted, and the heat gradually raised: in ten minutes an inflammable gas came over, which in ten minutes more burnt with a violet flame, producing much fume; in ten minutes more the green vapours of potassium appeared. The receiver containing naphtha was now adapted, so that the end of the barrel should dip into the fluid; the liberation of gas was very rapid, and it frequently inflamed spontaneously, burning with a white violet flame. In about twenty-five minutes from the application of the receiver, the gas diminished in quantity, and soon entirely ceased coming over; the receiver was separated, and found to contain 150 grains of potassium.

Eight ounces of fused sub-carbonate of potash, 6 ounces of iron filing, and 2 ounces of charcoal treated in the same way, gave 140 grains of potassium.

To ascertain the effect of the charcoal in these experiments, 3 ounces were mixed with 6 ounces of fused sub-carbonate of potash. The result was much inflammable gas, a pyrophorus powder, and 180 grains of potassium.

When iron alone was used, not a particle of potassium could be obtained at the heat, to which only this apparatus could be raised.

Crude tartar was then used; it was introduced into the apparatus and heated, till the acid was decomposed; then the tube removed, cleaned, and again attached, and the heat raised as in the ordinary process. The mean of many experiments gave nearly 300 grains of potassium from 24 ounces of crude tartar. Not more than an ounce of alkali was found at any one time in the retort after the operation. When the tartar was previously mixed with $\frac{1}{12}$ of charcoal, the product was greater.

In the preparation of sodium, caustic soda, and the subcarbonate of soda were both used at different times, and with the same success as attended the former experiments.

M. Brunner remarks, that a large quantity of the metal contained in the alkali, always disappeared in these experiments; and concludes, that it was carried off in vapour. He endeavoured to condense it, but without success. He states, in conclusion, that the apparatus is cheap and durable, having served for as many as thirty operations: that the process is easy and agreeable compared to that by iron at the high temperature: and that, as the vegetable salts with a little additional charcoal, are the best sources of the metals, so the process becomes very economical.—*Bib. Univ.* xxii. 36.

7. *Hydrocyanic acid, Preparation of.*—M. Pessina, of Milan, prepares hydrocyanic acid in the following manner, which is said to be much more economical than any other process known. Eighteen parts of triple prussiate of potash and iron are powdered very fine, and carefully introduced into the bulb of a small tubulated glass retort, a very small tubulated balloon is then attached to the retort; it is furnished with a conducting tube which dips into the first flask, containing a little distilled water. The rest of the apparatus is contrived so as to prevent absorption. A cold mixture of nine parts of oil of vitriol, and twelve parts of water, is then poured into the retort, the retort closed and the whole left for 12 hours, the balloon being surrounded with ice, and the neck of the retort constantly cooled with wet cloths.—The materials are then to be heated a little, and continued so until the striæ, which are observed in the neck of the retort become more rare, and, until a blue substance rises, which appears as if it would pass into the receiver. The heat is then to be discontinued, the apparatus allowed to cool, and the contents of the receiver preserved in a proper vessel. The hydrocyanic acid, thus obtained, is perfectly pure, and of a specific gravity of 0.898 or 0.9. Its quantity, in relation to the

quantity of substances used, is not stated.—*Giornale di Fisica*, v. 285.

8. *Production of Cyanurets.*—Cyanogen, according to M. Brunner, is formed whenever a potash salt with a vegetable acid is burnt with nitre:—ten parts of cream of tartar with one of nitre, or two parts of acetate of potash with one of nitre, when burnt, leave a product containing a notable proportion of cyanogen. It has been shewn by M. Pagenstecher, that when eight parts of nitre and five parts of tartar are burnt together, ammonia is formed.

9. *Iodide of Nitrogen.*—M. Serullas describes the following process, for the preparation of this detonating compound. Form a sub-chloride of iodine, to which, add ammonia in excess; muriatic acid is formed, and the iodine is almost entirely combined with the nitrogen, scarcely any hydriodate of ammonia being formed. The solid substance produced, is to be thrown on a filter, washed, and dried carefully. In the usual method, scarcely a fourth part of the iodine enters into combination with the nitrogen.—*Ann. de Chim.* xxii. 186.

10. *Thenard's Blue.*—This blue is considered by M. Thenard, as a combination of alumine and oxide of cobalt, and is prepared in the following manner. Nitrate of cobalt prepared in the usual way, from the ore of cobalt by torrefaction, digestion in nitric acid, evaporation, and solution, is to be precipitated by a solution of sub-phosphate of soda. The insoluble phosphate of cobalt is to be well washed, and then collected together, whilst in the gelatinous state, and mixed in the most perfect manner possible, with eight times as much hydrate of alumina in the same state. The mixture is spread on smooth plates, dried in a stove, when hard and brittle reduced to powder, and heated in a covered earthen crucible. After half an hour's ignition, it should be taken from the fire, and should then be of the colour required. The operation is always successful if the precautions be attended to, and it is particularly important, that the gelatinous alumina shall have been precipitated by an excess of ammonia, and has been well washed with very pure water, until quite free from impurity.

The arseniate of cobalt may be employed in place of the phosphate, but it requires twice as much alumina to be mixed with it.—*Dict. Tech.*—*Tech. Rep.* iii. 340.

11. *On a Per-sulphate of Iron and Ammonia.*—Dr. Forchhammer having prepared a solution of gold by means of nitric acid and muriate of ammonia, and precipitated the gold by proto-sulphate of iron, the clear solution was concentrated to

the consistence of syrup, and suffered to remain for a month; when beautiful octoëdral crystals, of a wine-yellow colour, were formed on the sides of the vessel. On examination, it was found to contain ammonia, and to be an alum, in which peroxide of iron supplied the place of alumina.

The salt dissolves in three parts of water at 60°, and, by repeated crystallization, may be obtained, perfectly colourless. On careful analysis, 100 parts appeared to be composed of

Per-sulphate of iron . .	41.807
Sulphate of ammonia .	12.366
Sulphate of alumina . .	0.870
Water	

On further examination, Dr. Forchhammer found the sulphate of alumina to be accidental, and neglecting it, ascertained the composition to be,

Per-sulphate of iron . .	41.95
Sulphate of ammonia . .	12.11
Water	45.94

He considers it as identical with the salt formerly described by Mr. Cooper, as a bi-persulphate of iron.

As the results deducible from this analysis seemed to agree so well with M. Mitscherlich's idea, that per-oxide of iron and alumina are isomorphous, and afforded additional proof of the correctness of his views, Dr. Forchhammer was more earnest to ascertain the exact quantity of water, and to compare it with ammonia alum; which salt gave, on analysis,

Sulphuric acid	35.90
Alumina	11.50
Ammonia	3.86
Water and loss	48.74

This alum is, therefore, composed of three atoms of sulphate of alumina, one atom of sulphate of ammonia, and 24 atoms of water—and the triple salt above described, of three atoms of per-sulphate of iron, one atom of sulphate of ammonia, and 24 atoms of water.—*Ann. Phil.* v.

12. *Test for Proto-salts of Iron.*—Professor Ficinus, of Dresden, strongly recommends a solution of muriate of gold, as the most delicate of all tests for the presence of protoxide of iron in solution, surpassing considerably even the gall nut. It requires the presence of carbonate of soda, which, in some analyses, may perhaps interfere with its use. A grain of green vitriol, with an equal weight of soda, dissolved in four pints of water, produces, with a drop of solution of muriate of gold, a strong precipitate, which gradually assumes a purple colour. Without the soda, the effect did not appear in less than three

days. M. Ficinus thinks the process may be improved even to the determination of the quantity of protoxide of iron present. *Bib. Univ.*

13. *Test for Barytes and Strontia.*—At p. 189, vol. x. is a process to distinguish between barytes and strontian; the repetition of it in most of the chemical journals is a proof that such a test was wanted. Mr. Smithson recommends the following as better. Put a particle of the soluble salt formed, into a drop of muriatic acid, on a plate of glass, and let the solution crystallize spontaneously. The crystals of chloride of barium, in rectangular eight-sided plates, are immediately distinguishable from the fibrous crystals of chloride of strontium.

As a test between the sulphates of the two earths, Mr. Smithson directs, that the mineral, in fine powder, be blended with chloride of barium, and the mixture fused. The mass is to be put into spirit of wine, whose flame is coloured red, if the mineral was sulphate of strontium. The red colour of the flame is more apparent when the spirit is made to boil, while burning, by holding the platina spoon containing it over the lamp.—*Ann. Phil. N. S.* v. 359.

14. *Action of Phosphorus on Water.*—Mr. Phillips has ascertained, by direct experiments, that when phosphorus is preserved in water, there is a mutual action attended with decomposition of the fluid. The oxygen of the water forms, at first, oxide of phosphorus, and, eventually, phosphorous or phosphoric acid; whilst the hydrogen, combining with phosphorus also, forms phosphuretted hydrogen. These changes take place much more rapidly when light has access, than in the dark.—*Ann. Phil.* N. S.

15. *Fixedness of Sulphuric Acid.*—M. Bellani placed a thin plate of zinc in the upper part of a closed bottle, at the bottom of which was some concentrated sulphuric acid. No action had taken place at the end of two years, the zinc remaining as bright as at first. This fact is adduced in illustration of the fixedness of sulphuric acid at common temperatures.—*Giornale di Fisica*, v. 197.

16. *Effect of a Vacuum on Alkaline Carbonates, by Doebereiner*.—I have found that these carbonates, (bi-carbonates,) when dissolved in the smallest quantity of water possible, or when covered with water, and left for half an hour in a vacuum, lose one-fourth of their acid. If, after being thus treated, they are put in a graduated tube over mercury, and acted on by a saturated solution of proto-sulphate of manganese, only about half the quantity of carbonic acid is set free, which may be

obtained, if afterwards a sufficient quantity of acid be added, to decompose the carbonate of manganese formed. These alkaline carbonates are modified, therefore, like the radiated natron of Tripoli, which I have ascertained to be composed as follows:

Bi-carbonate of soda, 1 = 30 soda + 41.4 carbonic acid
Carbonate of soda . 1 = 30 —— + 20.7 carbonic acid
Water 4

The same compound, is formed, if one part of bi-carbonate of soda, and four of water, be boiled until gas ceases to be liberated. I have not as yet been able to obtain the radiated crystalline structure.—*Bib. Univ.* xxii. 123 [*].

17. *Formation of Calcareous Spar.*—Mr. Haig, on pouring out the contents of a bottle of Saratoga water, which had stood several years in a cellar, found the bottom to contain well-defined crystals of calcareous spar, which, on being split, exhibited the usual appearance of that substance.—*Edin. Journ.*

18. *Action of Animal Charcoal on Lime.*—Animal charcoal is not only capable of separating colouring matter and extractive from solution, but will even remove lime from them. This may be proved according to Payen, by boiling 100 parts of lime-water for a few seconds with 10 parts of animal charcoal, and then testing the clear liquor by oxalate of ammonia; not a particle of lime will be found in it. Vegetable charcoal, or lamp-black, do not produce this effect.

19. *Bizio on Virgin Wax.*—Sig. Bizio has separated wax into two substances: it is to be boiled in alcohol until the whole is dissolved, and the solution then allowed to cool, and its temperature lowered 10° or 20° below the freezing point; a large quantity of white matter then separates, which is the wax; and there remain in solution the colouring principle, and an acid substance, which strongly reddens tincture of turnsole. The solid precipitate being separated by a filter, the fluid was evaporated, and left a fatty substance, of the consistence of butter, of a yellow colour, having the odour of honey, and melting at a temperature of 116° F.—*Giornale di Fisica*, v. 374.

20. *Separation of Elaine from Oils.*—This process is due to M. Pictet, and is founded on the property possessed by stearine, of being saponified by cold strong alkaline solutions, which does not belong to elaine. In order to separate these two substances, a concentrated solution of caustic soda is poured on to oil, and agitated with it; it is then slightly

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[*] See Mr. Phillips on Alkaline Carbonates.

heated, to separate the elaine from the soap of stearine; is passed through a cloth, and, finally, the elaine separated from the excess of alkaline solution, by decantation. This process is successful with all oils, except those which are rancid, or have been altered by fire. The elaine is perfectly identical with that obtained by the processes of MM. Chevreul and Braconnot, *Ann. de Chim.* xxii.

21. *On the Clarification of Wine.*—There is sold in France, and at a very high price, relative to its value, a reddish-brown powder for clarifying wines. It is prescribed, in employing it, to put into a vessel the quantity of water or wine, which is usually mixed with whites of eggs, to sprinkle gently the powder on the liquid; and, when it is well mingled, to pour the mixture into a cask, finishing the operation in the usual way. M. Gay-Lussac says, that the clarifying-powder is nothing but dried blood, and that he has prepared some with particular care in the desiccation, which was even superior to that on sale. The whites of two eggs contain as much albumen (which is the sole clarifying principle) as the dose of powder prescribed for the clarification of a cask of two hundred litres. It will be found more beneficial to make use of the white of egg,—both in reference to economy, and to that of the bad odour of glue possessed by the solution of dried blood, which might affect the flavour of fine wines. M. Gay-Lussac has prepared a powder, with the whites of eggs dried, which has not the same inconveniences as blood, which mixes easily with water, and clarifies very well.

III. NATURAL HISTORY.

1. *Blumenbach on Irritability of the Tongue.*—I had the tongue of a four year old ox which had been killed in the common way, by opening the large vessels of the neck, cut out in my presence while yet warm, and at the same time the heart, in order that I might compare the oscillatory motion of this organ, which is by far the most irritable that we are acquainted with, with the motion of the tongue; and, when I excited both viscera at the same time, by the same mechanical stimuli, namely, incisions with a knife and pricks of a needle, the divided tongue appeared to all the bystanders to survive the heart more than seven minutes, and to retain the oscillation of its fibres altogether for a quarter of an hour; and so vivid were the movements when I cut across the fore part of the tongue, that the butcher's wife compared them to those of an eel in similar condition, quite in the way that Ovid has compared them to the motions of the tail of a mutilated snake.—*Edin, Phil. Jour.* VIII. 263.

2. *Sensation experienced at great Altitudes.*—Capt. Hodgson in his journey to the head of the Ganges, which he found in the midst of eternal snows, says, whilst speaking of the sensations felt at great altitudes, " We experienced considerable difficulty in breathing, and that peculiar sensation which is always felt at great elevations where there is any sort of herbage, though I never experienced the like on naked snow-beds, even when higher. Mountaineers, who know nothing of the thinness of the air, attribute the faintness to the exhalations from noxious plants; and I believe they are right, for a sickening effluvium was given out by them here, as well as on the heights under the snowy peaks which I passed over last year above the Setlej, though on the highest snow the faintness was not complained of, but only an inability to go far without stopping to take breath.—*Edin. Phil. Jour.*

3. *On the Action of Nitrogen in the Process of Respiration.*—Dr. Edwards, who is well known as an intelligent physiologist, concludes, from different experiments, and from the circumstance of the opposite results which they give, some indicating a diminution of the nitrogen of the air, others an increase of it, during respiration, that this gas is absorbed into the circulation, and afterwards discharged from it; and that each of these actions is regulated by the constitution, habit, and circumstances of the individual, and by the influences to which he may be subjected, the absorption being to a small extent, while the exhalation is considerable, and *vice versâ.*—*Journ. de Phys.*, *January*, 1823.

4. *Diabetes.*—M. Van Mons says, " I have met with a very singular diabetic urine; it gives no indication of ammonia with any chemical re-agent, nor does it possess the odour of urine; but this odour is strongly developed, and that also of ammonia, at the same time accompanied by a brisk effervescence, if a few drops of sulphuric acid be added to it. These products are supposed to arise from the action of the acid on the urea.—*Giornale de Fisica.*

5. *Toad in a Solid Rock.*—The workmen engaged in blasting rock from the bed of the Erie canal at Lockport in Niagara county, lately discovered, in a small cavity in the rock, a toad in the torpid state, which, on exposure to the air, instantly revived, but died a few minutes afterwards. The cavity was only large enough to contain the body without allowing room for motion. No communication existed with the atmosphere, the nearest approach to the surface was six inches through solid stone. It is not mentioned whether the rock was sandstone or limestone, but from the prevalence of limestone on the sur-

face of the contiguous country, it may be presumed to have been the latter. The country is wholly of secondary formation. Of the causes which enable animals of this class, which have been suddenly enveloped in strata of earth, or otherwise shut out from the air, without injury to the animal organ, to resume, for a limited period, the functions of life on being restored to the atmosphere, no explanation need here be given, as the occurrence is a very common one, and is, perhaps, always more or less the result of galvanic action.—*Silliman's Journal.*

6. *On the Sensitive Plant, (Mimosa Pudica). By M. Dutrochet.*—It is known that the movements of the leaves of this plant have their origin in certain enlargements situated at the articulation of the leaflets with the petiole, and of the petiole with the stem. Those only situated in the last articulation are of sufficient size to be submitted to experiment. If, by a longitudinal section, the lower half of this swelling be removed, the petiole will remain depressed, having lost the power of elevating itself; if the superior half be removed the petiole remains constantly elevated, having lost the power of depressing itself. These experiments prove that the motions of the petiole depend on the alternate turgescence of the upper and lower half of the enlargement situated at the point of articulation, and that contractibility is not the principle of these motions.

If one part of the plant be irritated, the others soon bear witness, by the successive falling of their leaves, that they have successively felt the irritation. Thus, if a leaflet be burnt slightly by a lens, the interior movement which is produced is propagated successively to the other leaflets of the leaf, and thence to the other leaves on the same stalk. M. Dutrochet found, 1. That this interior movement is transmitted equally well, either ascending or descending. 2. That it is also equally well transmitted, although a ring of bark be removed. 3. That it is transmitted also, even though the bark and the pith be removed, so that nothing remains to communicate between the two parts of the skin, except the woody fibres and vessels. 4. That it is transmitted also when the two parts communicate only by a shred of bark. 5. That it is transmitted when the communication is completed by the pith only. 6. But that it is not transmitted when the communication only exists by the cortical parenchyma. It results from these experiments that the interior movement, produced by irritation, is propagated by the ligneous fibres and the vessels. The propagation is more rapid in the petioles than in the body of the stem: in the first it moves through from $\frac{3}{10}$ to $\frac{6}{10}$ of an inch in a second, in the latter from $\frac{8}{100}$ to $\frac{12}{100}$ of an inch in the same time. External temperature does not appear to exert any influence upon the rapidity of the movement, but very sensibly affects its extent.

Absence of light, during a certain time, completely destroys the irritability of the plant. The change takes place more rapidly when the temperature is elevated, than when low. The return of the sun's influence readily restores the plant to its irritable state. It appears, therefore, that it is by the action of light, that the vital properties of vegetables are supported, as it is by the action of oxygen, that those of animals are preserved; consequently, etiolation is to the former, what asphyxia is to the latter.—*Jour. de Phys.* xcv. 474.

7. *Vegetation in Atmospheres of different Densities.*—The following experiments have been made by Professor Dobereiner of Jena. Two glass vessels were procured, each of the capacity of 320 cubic inches, two portions of barley were sown in portions of the same earth, and moistened in the same degree, and then placed one in each vessel. The air was now exhausted in one, till reduced to the pressure of 14 inches of mercury, and condensed in the other, until the pressure equalled 56 inches. Germination took place in both nearly at the same time, and the leaflets appeared of the same green tint; but, at the end of 15 days, the following differences existed. The shoots in the rarefied air were 6 inches in length, and from 9 to 10 inches in the condensed air. The first were expanded and soft; the last rolled round the stem and solid. The first were wet on their surface, and especially towards the extremities; the last were nearly dry. "I am disposed," says M. Dobereiner "to believe, that the diminution in the size of plants, as they rise into higher regions on mountains, depends more on the diminution of pressure than of heat. The phenomena of drops of water on the leaves in the rarefied air, calls to my mind the relation of a young Englishman, who, whilst passing through Spanish America as a prisoner, remarked, that on the highest mountains of the country, the trees continually transpired a quantity of water, even in the dryest weather; the water falling sometimes like rain."—*Bib. Univ.* xxii. 121.

8. *Fruit-Trees.*—The growth of weeds round fruit-trees recently transplanted does them much injury, and diminishes their fruit in size and quality. Sonnini in his Bibliothèque Physico-économique states, that to prevent this, the Germans spread on the ground, round the fresh transplanted trees, as far as their roots extend, the refuse stalks of flax after the fibrous part has been separated. This gives them surprising vigour. No weed will grow under flax refuse, and the earth remains fresh and loose. Old trees, treated in the same manner when languishing in an orchard, will recover and push out vigorous

shoots. In place of the flax-stalks the leaves which fall from trees in Autumn may be substituted, but they must be covered with waste twigs, or any thing else that will prevent the wind from blowing them away.—*Phil. Mag.*

9. *Mesotype from Mount Vesuvius.*—Il Conte Paoli has ascertained the existence of mesotype among the products of Mount Vesuvius. He describes the fibrous mesotype and the hyaline mesotype, and has no doubt of their being real volcanic products formed in the lava at the time of cooling.

10. *Native Sulphate of Iron and Alumina.*—This is a salt which has lately been found in abundance in the slate clay of the deserted coal-mines of Hurlet and Campsie, and results from the decomposition and mutual action of pyrites on the clay. It was given by Mr. Macintosh to Mr. Phillips, who describes it as existing in the state of soft, delicate, silky, colourless fibres, resembling asbestos in appearance. By exposure to moist air the iron becomes peroxidized. It dissolves in water, yielding on evaporation crystals of sulphate of iron, and a mother liquor of sulphate of alumina. Its solution with salts of potash or ammonia yields alum. The salt on analysis was found to be composed of

Sulphuric acid	30.9	or 4 atoms	= 160
Protoxide of iron	20.7	3	= 108
Alumina	5.2	1	= 27
Water	43.2	25	= 225
	100		520

Ann. Phil.

11. *Bitumen in Minerals.*—In a curious paper upon the analysis of minerals, lately communicated to the Royal Society by the Right Hon. George Knox, he demonstrates the existence of bitumen in a great variety of mineral products where it has hitherto escaped observation, such as basalt, greenstone, serpentine, mica, *&c.*; and shows the necessity of attending to this volatile ingredient in all cases of analysis, where it has been generally suffered to escape observation from the loss by ignition having too commonly been ascribed to *water*. He recommends, with this view, that distillation, in a proper apparatus, should always precede the other steps of analysis, and that the nature of the volatile products, thus obtained, should be particularly examined.

12. *Italian Marble.*—The workmen employed in working the marble-quarry, discovered near Florence, proceed with activity; they have opened a way leading to Mount Altissimo, near Sevarezza. The first blocks were sent to Paris, the others are

reserved for Florence and Rome. These excavations will provide for Tuscany an important branch of industry and commerce.

13. *Bagne Lake and Glacier.*—A description was formerly given (v. 372 and vi. 166.) of the singular lake which had formed in the valley of Bagne, in consequence of the blocking up of the river Dranse by a glacier, and also of the immense destruction it occasioned by overthrowing its barrier, and escaping at once into the lands beneath it. Up to the year 1805, no glacier of this kind existed, but a large one on the precipices above continually sent down blocks and masses of snow and ice, which were removed by the waters of the rivers. It was the cold years succeeding 1805 that gave rise to the permanent formation of the lower glacier, for the masses of snow that fell into the river were so large that it had not the power to remove them, though it found a passage by filtration through them; and then succeeding winters hardened and consolidated the whole until it gave rise to the catastrophe already described.

The event which then took place, did not remove the whole of the lower glacier or barrier; on the contrary, scarcely a twentieth part was broken down, and the river remained forced from its old bed, and bordered on one side by the glacier, which accumulated so rapidly, that, at the end of 1819, the barrier to the passage of the river was almost as complete as before its breaking up by the weight of the lake.

It became, therefore, an important object to prevent a repetition of the former catastrophe, by the adoption of such means as would diminish, or, at least, prevent the increase of the barrier. Blasting by gunpowder was found inadmissible from the difficulty of firing the powder at considerable depths in the ice, and from the comparatively small masses removed by this means. After much consideration and many trials, a mode has been adopted and put in execution by M. Venetz, which promises the greatest success.

M. Venetz had remarked that the glacier could not support itself where the river was of a certain width, but fell into it, and was dissolved; whereas, where the river was comparatively narrow, the ice and snow formed a vault over it, and consequently tended to the preservation of any portion falling from the glacier above. Perceiving also the effect of the river in dissolving the parts it came in contact with, he formed and executed the design of bringing the streams of the neighbouring mountains by a canal to Mauvoisin, opposite the highest part of the glacier, where it touched that mountain. From hence it was conducted, by wooden troughs, on to the glacier in a direction parallel to the valley. The water was divided into two streams, one falling nearly on the one edge of the Dranse, and the other on the other; and having been warmed by the sun in its course, soon cut very deep channels in the ice. When they reached the river, the troughs were removed a few feet, and thus the streams produced the effect of a saw, which, dividing the ice, forced the portion between them to fall into the Dranse.

When the weather is fine, these streams, which are not more than four or five inches in diameter, act with extraordinary power, piercing a hole 200 feet deep and six feet in diameter in 24 hours. They are calculated to remove one hundred thousand cubical feet of ice from the barrier daily, and it is supposed that, if the weather is fine, the whole will be removed in three years.

At the end of the season of 1822, the Dranse remained covered only for a length of 80 toises (of six feet), whereas at the commencement of the operation it was covered over a length of 225 toises. M. Venetz estimates the quantity of ice, removed in 1822, as between eleven and twelve millions of cubical feet.—*Bib. Univer*. xxii. 58.

14. *On the Theory of Falling Stars.*—M. Bellani, in a mémoire on the meteors called falling stars, supports the theory that they are formed by the combustion of trains of inflammable gases or vapours in the atmosphere. He thinks that these trains may exist in the higher regions without being dissipated, in consequence of the general and perfect tranquillity which may be considered as existing there. He endeavours to combat the difficulty which is generally urged to such a theory, of the diminished inflammability of any gaseous or vaporous mixture by expansion, by referring to the vapour of phosphorus, stating, "that phosphorus becomes luminous, or suffers a slow combustion, at a temperature so much the lower as the quantity of oxygen gas in a determinate space is rendered smaller, either by mixture with other gases, or by rarefaction;" and then ventures the conjecture, that there may be other substances, capable by natural operations of being reduced into the state of vapour or gas; and which, though at common temperature and pressure are not inflammable, may become so by being elevated in the atmosphere.—*Giornale di Fisica*, v. 195.

15. *Preservation of Anatomical Preparations.*—Dr. Macartney, of Dublin, employs for this purpose a solution of alum and nitre, which preserves the natural appearance of most of the parts of the body much better than spirit of wine, or any other liquid hitherto employed. In order to impregnate entirely anatomical preparations, the liquid ought to be renewed from time to time at first. The proportion of the two salts and the strength of the solution should vary according to circumstances. The solution possesses such an antiseptic power that it destroys completely, in a few days, the fœtor of the most putrid animal substances.—*Ann. de Chim.*, xxi. 223.

Art. XV.—METEOROLOGICAL DIARY for the Months of March, April and May, 1823, kept at Earl Spencer's Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For March, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Saturday	1	31	43	29.70	29.80	WbN	NW
Sunday	2	33	47	29.83	29.65	WbS	NW
Monday	3	39	49	29.50	29.28	WbS	WbS
Tuesday	4	38	45	29.10	29.10	W	WbN
Wednesday	5	35	43	29.40	29.30	WbN	NbW
Thursday	6	32	37	29.60	29.60	NbW	N
Friday	7	25	35	29.30	28.97	SE	SE
Saturday	8	27	40	28.89	28.91	W	WbN
Sunday	9	21	39	29.05	29.32	N	NW
Monday	10	25	40	29.50	29.39	W	SE
Tuesday	11	34	47	29.46	29.59	SW	W
Wednesday	12	31	46	29.81	29.91	W	NW
Thursday	13	32	52	30.00	30.00	W	WbS
Friday	14	43	50	29.99	30.09	WbS	NE
Saturday	15	33	42	30.21	30.24	NE	NE
Sunday	16	37	47.5	30.25	30.10	ENE	W
Monday	17	38	48	29.93	29.90	W	NW
Tuesday	18	40	50	29.70	29.48	WbS	NW
Wednesday	19	30	35	29.50	29.71	NNW	NNW
Thursday	20	28	47	29.62	29.30	WbS	SW
Friday	21	43	52	29.17	29.08	SW	SW
Saturday	22	44	54	28.88	29.00	SW	SW
Sunday	23	37	47	29.49	29.60	NW	NW
Monday	24	28	46	29.93	30.03	NW	SE
Tuesday	25	34	46	30.10	30.07	SE	ESE
Wednesday	26	36	42	29.98	29.91	ENE	NE
Thursday	27	39	45	29.88	29.84	E	NE
Friday	28	40	46	29.84	29.87	NE	NE
Saturday	29	30	50	29.87	29.97	NE	SE
Sunday	30	40	57	29.82	29.77	SE	WSW
Monday	31	37	56	29.90	29.94	W	W

For April, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Tuesday	1	47.5	64	29.87	29.84	W	W
Wednesday	2	48	[illegible]	29.60	29.40	SW	W
Thursday	3	39	58	29.54	29.50	W	SSW
Friday	4	43	[illegible]	29.28	29.00	W	W
Saturday	5	40	53	28.98	28.98	W	NW
Sunday	6	39.5	45	29.17	29.32	NW	NbE
Monday	7	40	44	29.60	29.66	N	NE
Tuesday	8	38.5	44	29.80	29.74	EbN	E
Wednesday	9	37	46	29.74	29.77	E	NE
Thursday	10	33	50	29.99	30.00	E	E
Friday	11	32	50.5	30.10	30.10	E	EbN
Saturday	12	26.5	49	30.09	30.02	NE	ESE
Sunday	13	34	50	29.94	29.94	ESE	E
Monday	14	39	47	29.98	30.03	E	NNE
Tuesday	15	40	54	30.20	30.20	NE	NE
Wednesday	16	38	57	30.10	29.94	WSW	WSW
Thursday	17	50	62	29.83	29.78	W	WbN
Friday	18	38	56	29.53	29.33	WbN	WbN
Saturday	19	34	47	29.33	29.47	NW	NW
Sunday	20	31	54	29.75	29.85	NW	W
Monday	21	35	52	29.85	29.75	W	W
Tuesday	22	33	55	29.70	29.53	SW	SE
Wednesday	23	35	53	29.33	29.19	E	E
Thursday	24	40	52	29.39	29.66	E	NE
Friday	25	30.5	60	29.73	29.68	E	W
Saturday	26	42	44	29.58	29.61	E	E
Sunday	27	34	49	29.87	29.97	NE	NE
Monday	28	29.5	54	30 00	29.98	E	W
Tuesday	29	34	58	30.09	30.16	NW	W
Wednesday	30	33	65	30.28	30.26	WNW	NW

For May, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Thursday	1	36	67	30.26	30.20	W	SW
Friday	2	39	69	30.20	30.19	NW	NE
Saturday	3	38	70	30.19	30.19	NE	NE
Sunday	4	42	54	30.27	30.20	E	SE
Monday	5	37	65	30.10	29.90	ESE	SE
Tuesday	6	43	69	29.82	29.72	S	SE
Wednesday	7	46	73	29.70	29.67	SE	WbS
Thursday	8	50	65	29.63	29.53	SW	SW
Friday	9	43	64	29.45	29.62	WbS	WbS
Saturday	10	41	65	29.68	29.58	WbS	SbE
Sunday	11	50	58	29.50	29.38	WbS	WbS
Monday	12	51	63	29.37	29.44	WbS	WbS
Tuesday	13	49	65	29.40	29.41	W	W
Wednesday	14	40	60	29.50	29.66	W	W
Thursday	15	44	65	29.80	29.90	W	W
Friday	16	48	62	29.78	29.80	W	W
Saturday	17	51	59	29.70	29.93	W	W
Sunday	18	32.5	64	30.07	29.92	W	WbS
Monday	19	39	62	29.82	29.60	SE	SE
Tuesday	20	50	66	29.58	29.52	E	SW
Wednesday	21	52	64	29.41	29.51	SW	SSW
Thursday	22	49	62	29 52	29 57	ESE	W
Friday	23	46	63	29.62	29.71	SW	WbS
Saturday	24	44	66	29.72	29.72	SbE	S
Sunday	25	52	65	29.58	29.52	SE	S
Monday	26	46	64	29.57	29.67	S	SE
Tuesday	27	40	65	29.87	29.87	SE	NNE
Wednesday	28	45	67	29.93	29.93	NE	E
Thursday	29	46	66	30.00	30.00	ESE	W
Friday	30	45	70	30 03	30.02	W	WSW
Saturday	31	45	72	30 10	30.08	SE	SE

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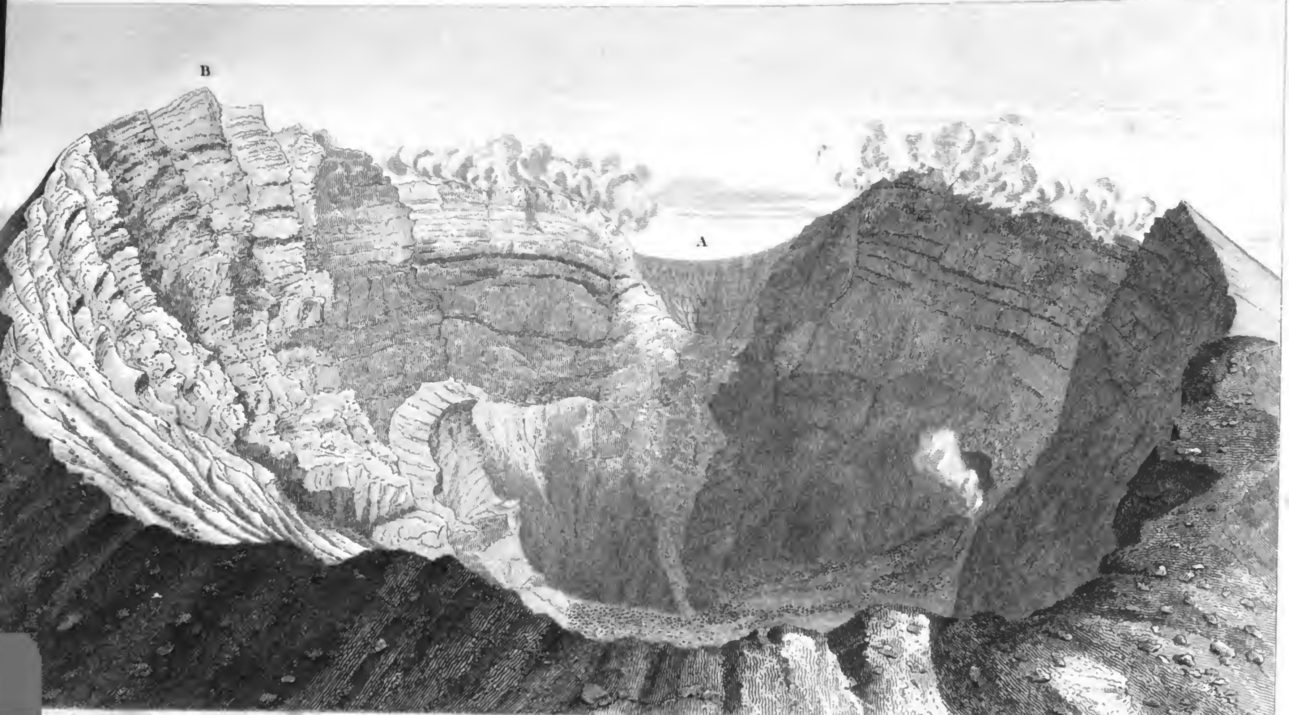

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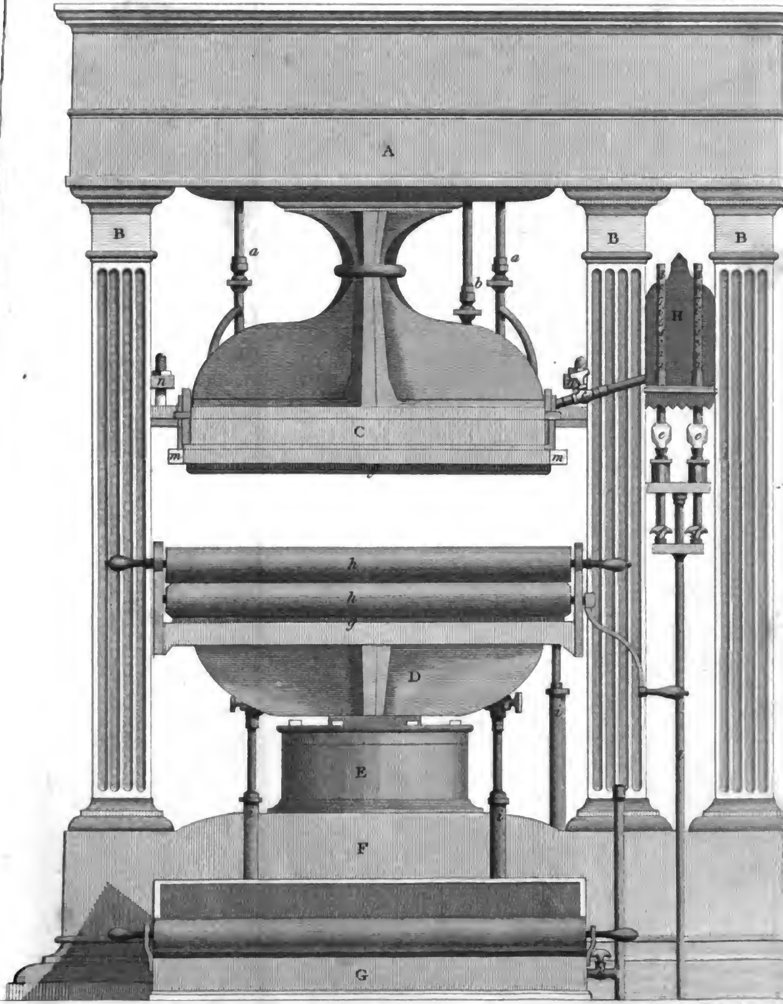

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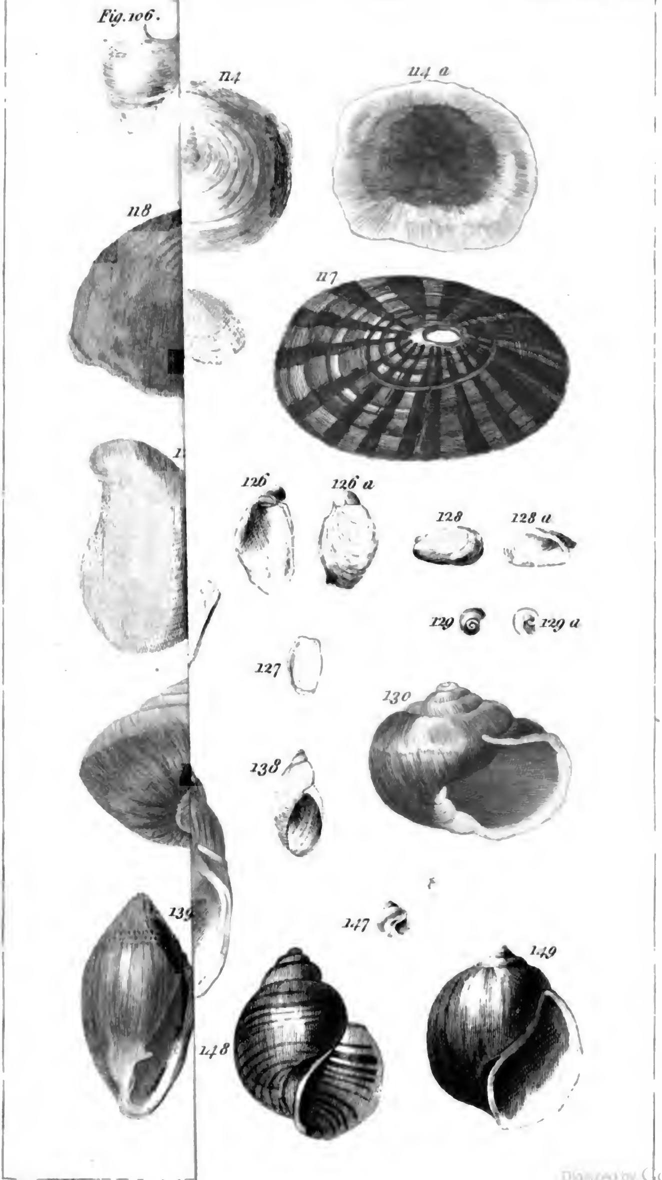

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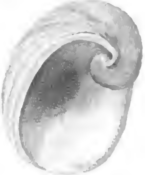

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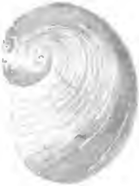

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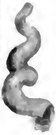

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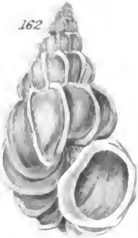

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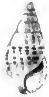

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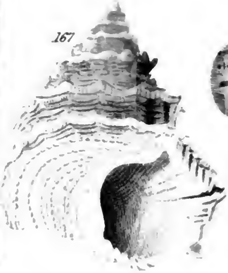

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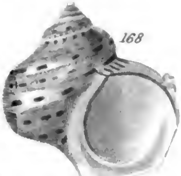

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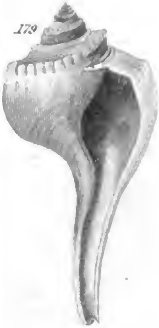

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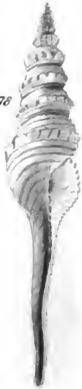

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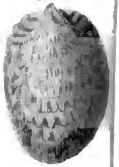

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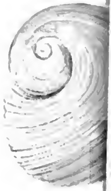

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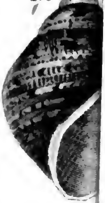

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